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IMPERIAL VALLEY SETTLERS' CROP MANUAL

BY

J. ELIOT COIT AND WALTER E. PACKARD

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IMPERIAL VALLEY SETTLERS' CROP MANUAL

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J. ELIOT COIT and WALTER E. PACKARD

INTRODUCTION.

The Imperial Valley is indeed a new country, for it has been the abode of man for but little more than ten years. In 1900 this great Valley was an uninhabited solitude with scant vegetation. Typical desert plant life was fairly well distributed over the total area but the native flora consisted of a remarkably small number of species. The valley floor was studded here and there with clumps of the creasote bush (*Larrea tridentata*), the mesquite (*Prosopis juliflora*), and shad scale (*Atriplex canescens*). On alkali spots the saltwort (*Suaeda torreyana*) predominated, while along the beds of dry water courses the arrow weed (*Pluchea sericea*) and some poplars were to be found. The absence of water and the pitiless sun made this country very difficult of exploration and it had long been regarded by many as absolutely worthless. In March, 1902, however, water for irrigation purposes was first turned into the Valley from the Colorado River and as large numbers of hardy pioneer settlers began to arrive, there immediately began one of the most rapid and altogether astonishing transformations which has ever come over a landscape. "From Desert to Garden," "From Worthlessness to Wealth," "A Submarine Empire Where the Mirage has been Materialized,"—these are some of the expressions used by different men to indicate the extent and quality of the transformation.

As in other newly settled irrigated areas, the first crops grown were those which would yield a quick harvest and bring fair returns. Thus during the first few years the leading crops were barley, milo maize, wheat, kafir corn, and sorghum. As soon as a quantity of feed was produced cattle and hogs were brought in and the dairy industry began to develop. The almost continuous growth and satisfactory yields of alfalfa made it a very popular crop and within five years the area in alfalfa increased to over fifty-five thousand acres.

With the completion of the railroad from Imperial Junction to Calexico on the International line it became practicable to raise more perishable crops for shipment to eastern markets. The soil and climate were found to be well suited for producing early cantaloupes. At first the profits were large and the area devoted to this crop increased rapidly until in 1908 nearly 10,000 acres were planted. This proved to be too much with the methods of marketing then in vogue and while a fine crop of melons was produced, much money was lost. Subsequent crops being smaller in amount were better handled and have paid well.

Fig. 1.—The Valley floor before irrigation began.

By the winter of 1908 a large number of different crops were being experimented with by various ranchers and it became more and more evident that on account of the fact that this great inland valley possessed climatic and soil conditions unique in American agriculture, that it was imperative that a public experiment station, supported by the state, be established in the valley in order that the life history, adaptation, and methods of culture of all crops might be studied scientifically and the results published for the benefit of all the residents in the valley and especially for settlers newly arrived from the east.

Accordingly the following bill was prepared and passed the State Legislature early in 1908:

"An Act making an appropriation for the investigation of agricultural and horticultural problems and conditions in Imperial Valley

and providing for the establishment in said county of a branch agricultural experiment station for the purpose of prosecuting said work.

"The people of the State of California, represented in senate and assembly, do enact as follows:

"Section 1. The regents of the University of California are hereby directed to cause to be prosecuted, through the Southern California Pathological Laboratory and branch agricultural experiment station, investigations on the conditions and problems attending the culture of crops in the region known as the Imperial Valley and similar adjacent sections.

"Sec. 2. Such investigations shall be particularly directed toward the solution of various difficulties and problems affecting the growing of crops, which have arisen in said region on account of the unique natural conditions obtaining in that portion of the State.

"Sec. 3. The regents of the University of California are hereby authorized to establish at some suitable point in Imperial county a branch agricultural experiment station for the purpose of carrying on the work herein provided for; *provided* the necessary land therefor is obtained without cost to the State.

"Sec. 4. The sum of six thousand dollars (6,000) is hereby appropriated out of any money in the State Treasury not otherwise appropriated to be expended by the regents of the University of California in carrying out the purposes of this act, and the state controller is hereby authorized and directed to draw his warrant for the same, payable to the regents of the University of California, and the treasurer of the State is hereby directed to pay such warrant."

Accordingly a public hearing was held in El Centro in September, 1909, to which everyone interested in the establishment of the station was invited. The consensus of opinion at this hearing seemed to be that the amount of money appropriated was insufficient to fully establish a station according to Section 3 of the law and that it should be used in securing one or more men to carry on coöperative experiments and to make a general survey of the conditions and needs in regard to experimental work; the work conforming to the requirements of Section 1 of the law. This has been carried out and the present publication is offered as the result of a study of the plant life history of the region with particular reference to the adaptations of the different crops.

The information presented herewith has been drawn from many sources. Some field experiments have been carried out even in the short time which has elapsed since the work was begun. The authors

have visited and sent letters to hundreds of ranchers in all parts of the valley in the work of collecting together the results of private experimentation. This information has been sifted, analyzed and arranged in order. Considerable data was obtained from the older irrigated Coachella Valley and adapted to the conditions in Imperial Valley. The findings of the branch station of the Arizona Experiment Station at Yuma in the Colorado River Valley have been given

Fig. 2.—Scene on Whiting Ranch after eight years of irrigation.

due consideration, for this region has much in common with the Imperial Valley. After exhausting all available sources of information, there of course still remained a number of crops concerning which but little definite data could be gained.

This bulletin represents, therefore, to a certain extent, a digest of indications as well as actual experimental results, and we hope that in as much as it is intended primarily for newly arrived settlers who may be largely ignorant of local conditions, that it will be received with charity by those older residents of the valley who have gained by costly experience much of the information we would disseminate.

THE WEATHER CONDITIONS.

On account of the short time during which the Imperial Valley has been settled the available weather records are very meagre and fragmentary. They do not extend back through a sufficient number of years to constitute a body of data from which reliable averages may

be computed. In studying the relation between climate and crops, however, the extremes are much more important than the means and constitute in most cases the factor which determines the possibilities of growth.

In common with other inland arid regions the weather of the Imperial Valley is noted for its extremes. It is characterized by changes and variations both in temperatures, wind velocity and humidity which are often very sudden. Being hemmed in by mountains on the east, north and west, the valley is denied the great regulating influence of a large and deep body of water. Variations in temperature within each twenty-four hours are usually great, and sometimes amount to as much as fifty degrees. Throughout a large part of the year the relative humidity of the atmosphere is very low and consequently the days are relatively warmer and the nights relatively cooler than in humid and coast regions in the same latitude. A large amount of moisture in the air acts as a blanket in retarding the penetration and radiation of heat, and consequently where this is largely lacking the rapid heating of the air at sunrise and cooling off at sunset is very noticeable. On account of the dry air and the consequent rapid evaporation of moisture from the body the high temperatures of summer are not unbearable and do not seem nearly so high as the dry bulb thermometer may indicate. During a part of July and August when the relative humidity is increased by the proximity of thunder storms the weather is very unpleasant. During the winter months the climate is usually dry, crisp, and sunny, and is considered by all to be both delightful and invigorating.

Weekly Maximum and Minimum Temperatures and Weekly Averages of Relative Humidity.

Taken at El Centro by Capt. Allen Kelly.

1909	Max.	Min.	Av. Relative Humidity	1909	Max.	Min.	Av. Relative Humidity
Jan. 7	70	40	28	8	91	49	9
14	78	42	27	15	91	50	25
21	78	46	28	22	91	51	35
28	74	36	32	29	96	53	30
Feb. 4	70	38	28	May 6	100	55	18
11	69	39	27	13	97	56	35
18	75	40	19	20	94	55	25
25	80	41	11	27	101	60	25
Mar. 4	79	42	22	June 3	112	56	30
11	78	44	17	10	109	62	21
18	77	38	21	17	108	62	19
25	71	39	27	24	108	68	24
Apr. 1	82	51	15	July 1	114	72	27

1909	Max.	Min.	Av. Relative Humidity	1909	Max.	Min.	Av. Relative Humidity
July 8	108	66	23	Oct. 7	96	52	3
15	113	66	18	14	98	56	.....
22	114	74	31	21	95	52	.....
29	110	64	21	28	102	52	.....
Aug. 5	110	70	31	Nov. 4	96	45	.....
12	114	73	30	11	92	46	.....
19	102	70	37	18	80	37	9
26	108	81	26	25	86	39	17
Sept. 2	110	74	31	Dec. 2	78	34	9
9	107	72	52	9	64	48	.....
16	106	64	.....	16	74	35	.....
23	105	62	.....	23	59	27	.....
30	100	58	.....	30	68	32	.....

Daily Relative Humidity Records for 1909 Taken by U. S. Weather Bureau at Brawley, Cal.

Time of Observations 5 p.m.

Day of Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	41	36	31	17	6	9	13	13	42	19	15	45
2	43	33	34	12	10	8	24	18	18	38	16	42
3	45	83	33	13	10	21	34	25	27	25	17	17
4	46	43	26	30	11	21	23	32	35	22	24	21
5	44	42	23	20	10	9	10	77	47	24	19	30
6	46	64	40	24	13	6	14	34	48	15	23	42
7	49	56	19	16	15	17	17	24	41	21	22	43
8	44	34	21	18	12	14	9	33	23	18	25	43
9	54	50	29	14	18	9	10	18	15	13	33	72
10	46	51	16	13	15	9	9	17	26	14	35	50
11	31	55	30	29	8	9	12	14	11	26	49	24
12	46	66	18	16	22	9	12	36	14	26	43	26
13	57	43	19	13	35	9	14	37	10	26	32	26
14	60	26	16	16	14	11	22	50	14	22	51	25
15	57	39	18	29	15	8	31	52	19	23	33	33
16	39	25	25	19	12	11	30	91	17	40	22	28
17	37	39	20	23	12	14	26	56	14	33	27	19
18	42	31	36	32	16	27	26	42	14	29	31	24
19	42	23	22	29	26	14	24	33	16	17	44	19
20	49	37	40	20	18	9	13	24	12	27	25	93
21	46	44	31	30	25	10	12	22	25	22	52	65
22	50	14	82	11	25	14	43	20	22	22	39	87
23	55	15	52	14	25	10	25	29	24	14	46	75
24	34	32	42	17	11	17	33	39	23	24	42	49
25	63	34	33	15	9	16	22	34	24	15	51	52
26	58	33	85	15	9	28	13	35	23	18	94	47
27	68	31	39	10	16	20	8	27	53	28	40	50
28	51	31	36	21	19	23	6	27	12	16	29	49
29	34	.....	36	12	10	18	11	29	15	29	31	49
30	33	.....	13	7	8	13	22	89	21	24	38	33
31	44	.....	15	.....	8	.....	16	58	.....	23	.....	88
Av.	46.9	39.3	31.6	18.5	14.9	13.8	18.8	36.6	23.5	23.6	34.9	44.1

The average wind movement for the year is from five to six miles an hour and the usual direction is from the south and southwest. About every two or three weeks in the spring, however, and with longer intermissions in the summer and fall there arises a sudden strong wind which blows from one to four days at from fifteen to thirty-five miles per hour, usually from the northwest, but sometimes from the southwest. These winds are known locally as dust storms and carry sufficient impalpable dust to obscure completely at times the mountain ranges to the north and west. These winds have resulted in the piling

Fig. 3.—Typical hummock of wind-blown sand.

up along the northeastern side of the valley of sand dunes of considerable height and extent. The thunder storms so common during July and August in central Arizona are much less common in Imperial Valley, but during these months there is a marked increase in the relative humidity.

In view of the frequency of winds it is highly desirable that for the good of the orchards and the greater comfort of the home that the rate of tree planting in the valley be greatly increased. Tall windbreaks of eucalyptus or cottonwood running north and south at frequent intervals would do much to lessen the damage and discomfort due to these winds.

WIND VELOCITY.

Average Monthly Movement at Brawley, Cal. (U. S. Weather Bureau).

In Miles Per Hour.

	—1909—										—1910—		
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	A
Av. monthly mov't	7.9	9.0	8.7	6.8	6.4	5.9	5.4	4.9	5.4	4.7	4.5	5.8	6.
Max. for 5 min.	34	36	38	27	28	44	28	24	36	27	39	35	33

So far as the growth of crops is concerned the natural rainfall amounts to very little and cannot be depended on. Much of the precipitation comes in light showers and soon evaporates again into the air. The weather records of precipitation in the valley are so meagre as to be worth little. At Indio, however, near the northern end of the valley, the U. S. Weather Bureau has kept records of rainfall for thirty-two years and it is likely that the rainfall there is practically the same as in the Imperial Valley.

MONTHLY AND ANNUAL PRECIPITATION AT INDIO, RIVERSIDE COUNTY, CAL.

Elevation 20 feet.

Year	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Annual
1877	.....	.....	.....	.....	0	1.98	0.10	0	0	0	0	0	1.10
1878	0	0	0	0	0	1.00	0.60	0.30	0	0	0	0	1.30
1879	0	0	0	0	0.40	0	0	0	0	0	0	0	0.70
1880	0	0	0	0	0	0.70	3.45	0	0.50	0	0	0	3.95
1881	0	0	0	0	0	0	1.50	0	0	0	0	0	2.50
1882	0	0	0	0	1.00	0	0.80	1.13	0.11	0	0	0	2.96
1883	0	0	0	0.06	0	0.86	0	3.16	0.62	0.44	0.46	0	5.38
1884	0	0	0	0	0	0.70	0	0	0	0.10	0	0	1.00
1885	0	0	0	0	0.90	0	0	0	0	0	0	0	0.12
1886	0	0	0	0	0.12	0	0	0.93	0	0.30	0	0	1.43
1887	0	T	0.05	0.15	0	0	0.75	0	0	0	0	0	2.96
1888	0	0	0	0	1.10	1.11	0.57	0	1.05	0	0	0	6.47
1889	0	0.95	0	0.60	0.01	3.29	0.65	0.06	0	0	0	0	1.23
1890	0	0.10	0.20	0	0	0.22	0	1.90	0	0	0	0	3.31
1891	0	1.16	0	0	0	0.25	2.00	0.43	0.22	0.04	0.14	0	2.83
1892	0	0	0	0	0	0	0.03	0	1.60	0	0	0	2.64
1893	0.05	0.75	0.07	0	0.14	T	0	0	0	0	0	0	T
1894	T	0	0	0	0	0	6.01	0	0	0	0	T	6.01
1895	0	0	0	0	0	0	0.92	0	0	0	0	0	0.92
1896	0	0	0	0	0	0	1.10	0.19	0	0	0	0	3.39
1897	0	0	2.10	0	0	0	0.10	0	0.30	0	0	0	1.70
1898	0	0.30	0	0	0	1.00	0.40	0	0	0	0	0	1.30
1899	0	0	0.10	0	0.60	0.20	1.00	0	0.30	0.15	T	0	2.74
1900	0	0	0.08	1.04	0.17	0	0.29	1.46	0	0	0	0	1.75
1901	0	0	0	0	0	0	0.40	0.20	0	0	0	0	2.00
1902	0.10	0	0	0	0.50	0.80	0	0	0.20	0.75	0	0	1.58
1903	0	0.10	0.12	0	0	0.41	0.87	0.35	0.20	0	T	0	2.43
1904	T	0.33	0	0.80	0.19	0.41	0.87	2.00	1.30	0	T	0	5.37
1905	0	0	T	T	1.06	0.14	T	0.97	2.06	0.47	0	0	7.10
1906	T	1.07	0.04	T	0.60	1.89	0.59	0.63	0.96	0	0.05	0	3.88
1907	0	0	0	1.60	0.05	T	0.95	0.57	0.01	0	0	0	3.64
1908	T	0.45	1.60	0	0	0.06	0.28	0.29	0.45	0	0	0	.....
Av.	0	0.17	0.14	0.11	0.22	0.42	0.76	0.46	0.31	0.07	0.02	0	2.70

But not only has the Imperial Valley in common with other parts of the arid southwest, the lowest rainfall and lowest relative humidity, but it also has a greater amount of sunshine and a greater number of clear days in the year than any other area on the continent. Mr. E. F. Chumard, located two miles east of Heber, has furnished the Weather Bureau the following record of clear and cloudy days.

Sunshine Record in Days at Heber, Cal.

Year	Clear	Partly Cloudy	Cloudy
1906	290	38	37
1907	302	42	21
1908	308	37	20
1909	315	23	27

Fig. 4.—Cracking of new-formed soil in ditch bottom.

SOILS OF THE IMPERIAL VALLEY.

In general, the Imperial Valley is a constructional depression caused by the subsidence of a number of faulted strips.[1] Erosion played no part in its formation, as can be readily seen from the fact that the bed of the valley is far below sea level and therefore below any possible erosive action. At the time of this subsidence an arm of the ocean filled the valley thus formed, extending probably 200 miles north to San Gorgonio Pass. The Colorado River emptying into this gulf rapidly formed a massive delta which gradually reached across the gulf, coalescing with the small amount of aluvium and talus from

[1] U. S. G. S. Water Supply Paper No. 225, by W. C. Mendenhall.

the peninsula range. The river at that time probably carried as much material as at present, which, according to calculations by Forbes, would in one year cover one square mile with dry earth to a depth of fifty-three feet. The continuation of this process resulted in the formation of a barrier, leaving the northern end of the gulf an inland sea. The deposition of silt continued, the river following various courses across the delta, discharging both into the gulf and into what is now called the Salton Sink. This great inland sea, although probably refilled at various times by receiving the entire flow of the river, was gradually diminished by evaporation until the present floor of the valley was left dry.

Upon the northern slope of the delta thus formed lies the Imperial Valley. The main mass of soils were deposited in the quiet water which formerly filled the basin. On this account the floor of the valley is covered largely with a fine laminated silt, which is broken in places by more sandy areas deposited in the slowly moving water of the varying delta channels or blown in by the wind. The outer edges of the valley are covered by coarser silts and sands, some of which have been deposited by the wind and others by the intermittent torrential streams from the surrounding mountains. The accompanying cross section, taken from the logs of wells bored at various points between the towns of Holtville and El Centro shows the alternating soil strata so characteristic of the valley.

The drainage area of the Colorado River covers more than 225,000 square miles, including parts of Wyoming, Utah, Colorado, New Mexico, Nevada, California and all of Arizona. The soil formed by the disintegration and decomposition of the varied rocks of so large an area would naturally be expected to contain a plentiful supply of mineral plant food elements. The aridity of the climate which prevents the excessive leaching of soluble salts tends to maintain the initial fertility of such soils. The content of nitrogen, however, would presumably be low, as in most desert soils where humus forming vegetation is largely lacking. These facts are borne out by analyses made by the California Experiment Station.

Not only are the essential plant food elements, potassium and phosphorous, present in sufficient quantities, but the amount of carbonate of lime present is such that these elements should be made readily available. There is enough potash in the samples tested to render the soils permanently fertile in respect to this element. With the yearly addition of both potassium and phosphorous in the irrigation sediments the necessity of applying commercial fertilizers containing those elements may never arise. The proper physical condition must be main-

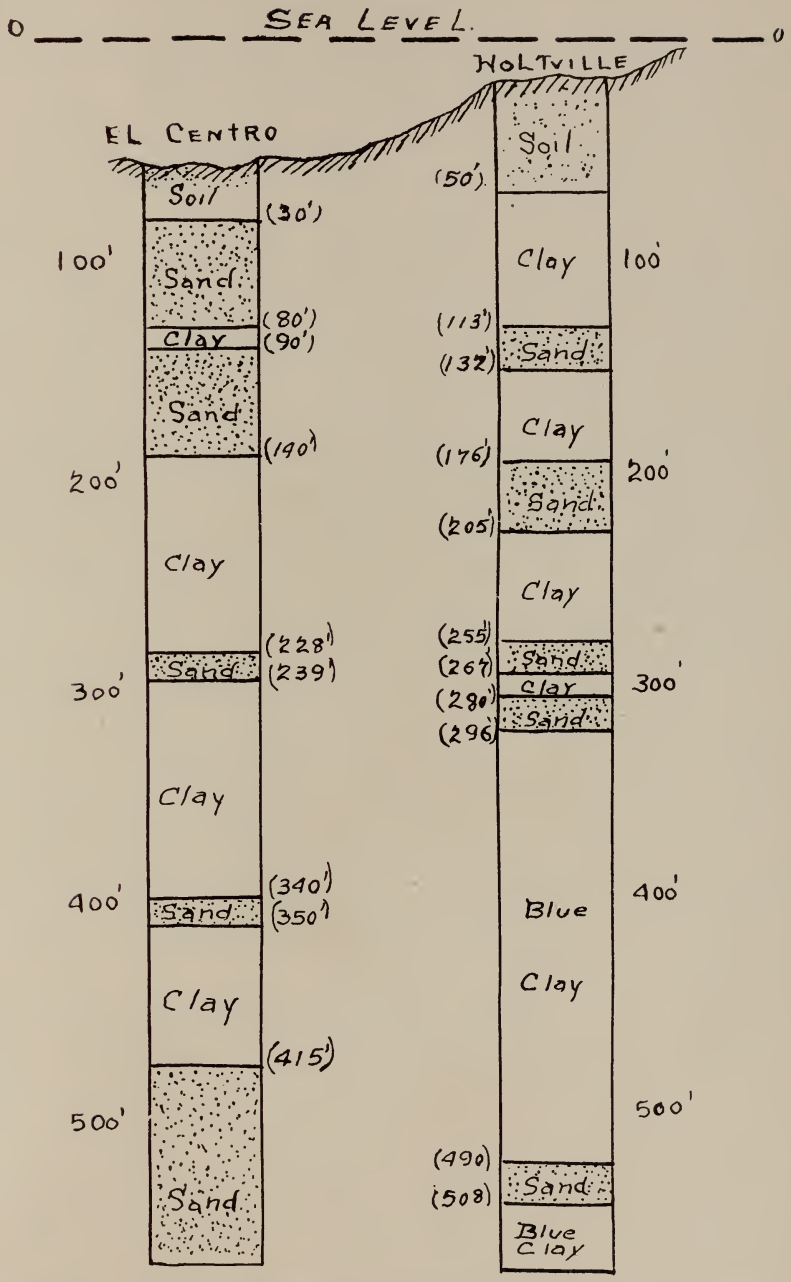

Fig. 5.—Logs of artesian wells drilled at Holtville and El Centro. (From "The Desert Farmer," April, 1910.)

tained, however, as upon this depends largely the promotion of necessary bacterial action, whereby not only the nitrogen but the other plant food elements are made available. In certain cases, however, fertilization with chemicals may prove to be profitable.

Type of Medium Hard Soil.					Type of Hard Soil.				
		Humus—Nitrogen in					Humus—Nitrogen in		
Depth, ft.	Humus	Humus	Soil	Phosphoric Acid	Depth, ft.	Humus	Humus	Soil	Phosphoric Acid
1	.30	5.15	.015	.13	1	.24	6.14	.020	.16
2	.23	5.49	.013	.13	2	.16	3.51	.006	.15
3	.22	6.38	.014	.12	3	.21	3.34	.007	.14
4	.31	4.54	.014	.13	4	.19	4.43	.008	.18

All of the valley soils are markedly deficient in humus and nitrogen, and it therefore follows that the highest possible production may not be reached on these soils without improvement in this respect. Both humus and nitrogen can be supplied by manure or by plowing under leguminous crops, such as cow peas, soy beans, alfalfa, etc. Plowing under old alfalfa fields is especially advisable, as the deep rooting habit of this crop enables it to open up the subsoil to both its physical and chemical betterment. By plowing under crops such as barley or winter rye, humus will be formed and the physical condition improved, although no nitrogen will be directly added.

Alkali is present in all arid soils, but is detrimental to plant growth in Imperial Valley in limited areas only. The presence of these salts has caused some apprehension among the settlers of the valley and as it often presents a serious problem in older irrigated sections, the subject of alkali and alkali reclamation will be discussed here more or less at length. Tables and formulas are avoided in order to prevent confusion.

The alkali salts in Imperial Valley soils originate both from saline deposits and from the decomposition of certain rock minerals. Some of these salts are nutritive, but all of them are detrimental to plant growth when present in excessive amounts. The nutritive alkalis (sulphate of potash, phosphate of soda and nitrate of soda) contain the three elements most generally lacking and are usually present in limited amounts, while the injurious alkalis, namely Glauber salt or sodium sulphate, common salt or sodium chloride, black alkali or sodium carbonate and bicarbonate, magnesium chloride, and epsum salts or magnesium sulphate are usually present in larger quantities, but as the less injurious chlorides and sulphates predominate in the

Imperial soils the alkali situation is not so serious as in many arid sections.

An alkali soil is usually a rich soil, because the presence of the salts usually indicates an abundance of soluble plant food elements. If the alkali content, either nutritive or otherwise, is too high, however, all ordinary plant life ceases. The ability of plants to withstand salt solutions varies with the kind of salts, some being more damaging than others. All ordinary plants are able to grow in soil containing the chloride in amounts up to two-tenths of one per cent, the sulphate up to seven-tenths of one per cent, while the carbonate becomes injurious when five one-hundredth to one-tenth of one per cent is present. This of course varies in different soils and with different crops. Not only does the black alkali injure the plants directly, but it puddles the soil, thus preventing drainage and proper aeration. In some cases gypsum is applied to land affected with black alkali for the purpose of changing the carbonate to less objectionable sulfate. There is only a small amount of black alkali in Imperial soils, however. The common black coloring noticed in many of the alkali patches is not usually caused by a humic solution but "merely by moisture which is tenaciously held by the chlorides of calcium and magnesium, impregnating the land and thus contrasting strongly with the grey tint of the general soil surface."[2]

As these salts are all soluble they move in the soil more or less with the movement of the soil moisture. After a short rain or irrigation the salts are carried down, but with the capillary rise of the moisture from below, the salts rise exactly as oil rises in a lamp wick, and are left on the surface of the ground when the water evaporates. Most of the damage from black alkali is due to this surface accumulation, as it has a corrosive action on the stems of plants, turning the bark and cambium layer black or dark brown, thus weakening and sometimes girdling the plants. Cultivation lessens this damage, for by keeping the soil well stirred incrustations of salts cannot form in contact with the plant. The chlorides affect the plants largely through osmotic poisoning, when damaging quantities are present.

Complete alkali reclamation can only be accomplished by washing the salts out of the soil and this, of course, means drainage. For this purpose tile drains are most satisfactory. It has been repeatedly demonstrated that alkali land can be reclaimed in this way economically. The cost of installing such drains should not be much greater than in the east where tile drainage is so commonly employed.

[2] Snow, Bull. 140, Calif. Exp. Station.

Inverted wooden troughs are sometimes used but are not satisfactory, as the wood rots too quickly. Surface drainage will wash the alkali down into the sub-soils and may carry some away in the natural drainage, but the amount actually taken out of the soil in this way is slight. In time the salts will reappear on the surface as they appeared in the first place. Thorough cultivation of the surface to prevent the capillary rise of moisture will, of course, help in holding the alkali down. Very little can be washed from the surface except in the case of the

Fig. 6.—Farm drain emptying into lower canal, as seen in the Salt River Valley.

hard soils, since the salts are carried down and not off. The economical reclamation of the bad alkali spots on the hard soil is impossible at present, because of its close texture. Gypsum is used in the case of black alkali to change the carbonate into the less injurious sulphate, which must then be washed out to entirely reclaim the land.

The channels of New and Alamo Rivers should make an excellent outlet for drains, both to carry away the alkali and to get rid of excess of water which is apt to collect in soil underlaid by thick layers of impervious clay. Alkali resistant crops, such as kafir corn or sugar beets, should be tried on these soils. Date palms, especially if once well started, will endure a large amount of alkali.

The compactness of the heavier soils in the valley renders them comparatively hard to manage. On account of the plasticity of the clay and fine silt in those soils, plowing and cultivation can be done

well only when the moisture conditions are just right. Water penetrates these soils very slowly, so that thorough irrigation is often difficult. In tests made on this soil after irrigation had been carried on for three months at two week periods, the percent of moisture in the first foot was 13.3, second foot 16.4 to 20.0, third foot 13.7, the fifth foot being dust dry. Crops on the hard soils tested were wilting when 13% moisture was present. In moisture tests made on heavy soils it would appear, therefore, that at least 13% is necessary for the life of ordinary plants, while on sandy loam soils alfalfa and grapes did well with only 7% of moisture present. In the sandy soils it was found that the moisture content increased with the depth, being greater at the fourth than at the first foot. Crops did not wilt in cases tested where the moisture averaged from 6% to 7%. The penetrability of the soil varies greatly, depending partly on the amount and character of the silt carried by the water, but in any case water must be applied oftener on heavy than on sandy soils.

The heavy soils of the valley represent the finest particles carried by the Colorado River and deposited in thin layers over these places where the land was annually overflowed or in the quiet waters formally filling the depression. The soil particles under such conditions are in a very finely divided state, having somewhat the characteristics of puddled soil. The aridity of the climate has prevented a large growth of tules or other water plants so that the physical conditions of the surface has not been opened up and improved by roots as in the case of soils in more humid regions. In order to loosen up these soils and render them more friable, the finer particles must be floculated or collected together into small bundles somewhat resembling minute pop-corn balls. This gives the soil more openness and allows the air and water to circulate more freely and allows such bacterial action as will render inert plant food available.

This process will take time but can be accomplished at least to a large extent by applying manure, plowing under cover crops (preferably alfalfa) and by as deep and thorough cultivation as can be economically given. An application of lime would help in floculating these soils, even though the content of lime is already quite high. The effect of the proper mechanical condition of soil is well illustrated on the edges of the borders in the fields where the alkali tends to floculate the particles, giving a loose, open condition where crops usually grow better than in other places. The deep penetration of the alfalfa roots is especially beneficial and will probably open up the sub-soils better than by using a sub-soiler. A sub-soiler used on these hard soils when wet would tend to compact the deeper layers rather than loosen them

up, and if the soil is dry the expense of running the subsoiler would be too great.

The improvement of the physical condition of the hard soils in Imperial Valley will come through the natural processes of good farming practice, including always a rotation of crops, using some deep rooted legume, such as alfalfa, these soils should lose much of their present objectionable features.

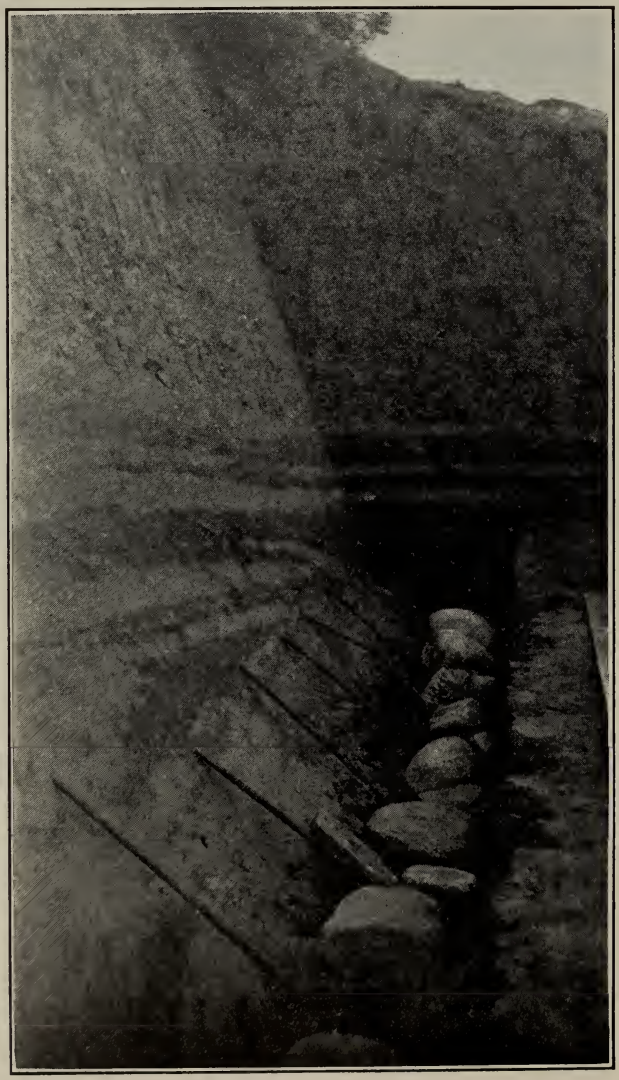

Fig. 7.—Excavation for concrete headgate showing alternating soil strata; and the foundation for reinforcement.

There is a very great difference in the various soil types in the valley, both chemically and mechanically, although the mechanical differences are much the most marked. Differences in alkalinity, however, have a more marked effect on native vegetation than mechanical differences. In summing up, a short discussion of each soil type follows:

The hard soils are intrinsically fertile, more fertile than the sands, but as has been pointed out their plastic and compact nature renders them difficult to handle. The physical condition must be improved before much of plant food can be made available to the plants. This soil forms the underlying strata over the entire valley, but appears on the surface only towards the central portion. The mechanical analysis made at Berkeley (California Experiment Station Bulletin No. 140), shows this soil to contain 28.78% of colloidal clay and 63.31% of fine silt, which gives it the characteristic sticky character. In those limited areas where this soil contains a high percentage of alkali, reclamation will be unprofitable, at least at present prices of land. Such reclamation would be extremely difficult from an economical point of view, because the compact character of the soil interferes with drainage.

The soil is best adapted at present to shallow rooted crops, such as barley, sorghum, Egyptian or kafir corn, or any of the grasses. Date palms will do well on this soil. Alfalfa, however, should be tried only after a couple of crops of barley have been grown. In this way such hard soils may be improved to some extent.

The medium hard type constitutes some of the best soil in the valley for certain crops, although it has some of the bad features of the heavier clays, but to a lesser degree. The mechanical analysis shows this soil to contain 14.34% clay and 15.34% fine silt, the rest being from a medium to a coarse silt with a very little sand intermixed. The soil is formed in thin layers as is the clay and becomes sticky when damp. This soil contains more nitrogen than any of the other soils, which may account in part for the fact that it has proved to be the best cotton land in the valley. This soil is best adapted to such field crops as cotton, grain, alfalfa, and sugar beets, although trees do well also. The soil can be greatly improved by the methods outlined above.

The sandy loam soil covers quite a large portion of the valley, usually overlying either clay or clay loam strata, to a depth of 3 feet or more. This soil contains little clay or fine silt, being made up mainly of coarser silt and very fine sand. This type of soil is very spotted in respect to the alkali content, being the worst soil in the valley in certain limited areas. Most of it is relatively free from damaging quantities of salts near the surface, so that with proper care

in handling the irrigation water the alkali should not ruin the soil. If care is not taken in applying the water, however, alkali will in time accumulate at the surface and destroy the vegetation, as it has done in so many irrigation enterprises.

This soil is best adapted to the cultivation of trees, vines, alfalfa, melons, or any garden truck. Roots will penetrate deeper and will therefore have a greater feeding area than in the hard soil when the best root development is restricted.

The dune sand is not so rich in plant food elements as any of the other soils and will need more fertilization, especially in nitrogen, before the best results can be obtained. This soil is carried by the winds and is therefore a nuisance in filling ditches and covering young crops. The early planting of eucalyptus and other windbreaks will do much to remedy this defect.

THE USE OF WATER IN IRRIGATION.

Repeated efforts have been made to reclaim the Colorado desert by utilizing the waters of the Colorado River, but not until 1900 was work actually begun on any canal system. The California Development Company, organized in 1898, appropriated the water and sold it to the various mutual water companies composed of the water users of the valley. Owing to many unforseen difficulties, prominent among them the breaking of the Colorado River into the valley in 1905, the stopping of which entailed immense expense, the California Development Company was put into the hands of a receiver in 1909. The outcome of this matter is still uncertain, but from present indications the water problems will soon be solved satisfactorily.

The amount of water in the Colorado is more than sufficient for all irrigation purposes in the valley, even when all irrigable land is reclaimed, and if proper use is made of this water before it is used in any other project up the river the future right to such water will, of course, be unquestioned. There have been a number of serious difficulties met in securing this supply and some damage has been done to crops at various times by the partial failure of the water supply, due mainly to deposits of silt in the intake. The water has never been turned off entirely, however, and the shortage has always been stopped quickly by forming a new intake channel or by the construction of temporary diversion works. As the delta channel of the Colorado is being constantly and rapidly raised by the continual deposit of silt, there is a constant tendency for the river to change its course toward the west, where the gradient is greater. On this account the future control of the river to prevent a repetition of the break of 1905

is a serious problem. This matter has been taken up by the Federal Government and an appropriation of $1,000,000 has been made to be expended at the discretion of the President in controlling the river. A levee is being constructed along the western bank of the river from

Fig. 8.—A typical canal in Imperial Valley showing water wheel used in raising water for domestic use.

the end of the present levee extending south of the head gates to a point twenty to twenty-five miles below, thus holding the water in the southwesterly course.

The quality of the water from the Colorado differs from that in most streams of the arid west in the amount of silt carried in suspension throughout the year. The water is always muddy, carrying

from 1/30 to 1/1200 parts silt by weight, amounting to about 35,000 acre feet of dry earth per year.[3] An acre foot of river water carries about 962 tons of silt. Not all of this reaches the fields, however, as a considerable amount is deposited in the canals. Since the soil of the valley is simply an accumulation of this sediment, the silt which comes onto the fields through the canals is a fertilizer, having the same chemical properties as the soil but being a little more finely divided, since the coarser particles are usually deposited in the canals.

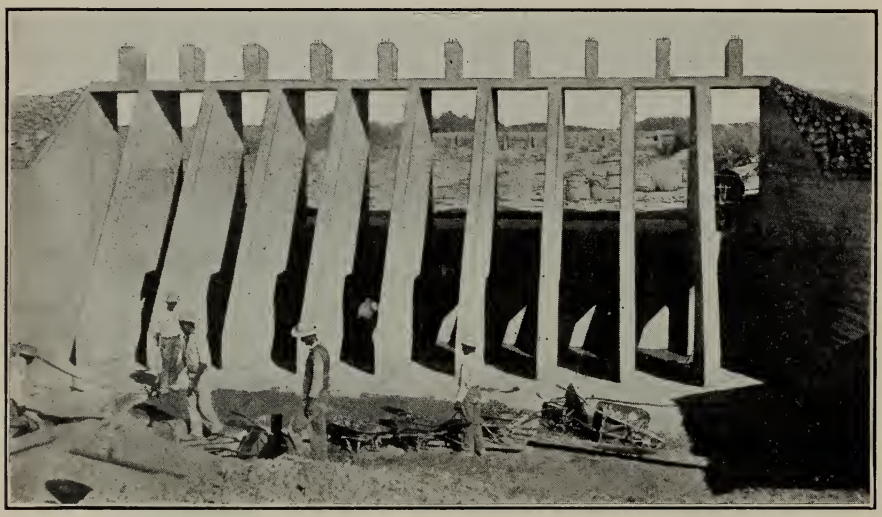

Fig. 9.—Showing construction of concrete headgate.

The chemical and physical condition of the sediments depends upon the source from which they come and consequently varies in the different seasons. During the winter months the river is low and the silt content is also low (62 parts in 100,000),[4] most of it coming from the upper drainage area of the Colorado where the river cuts through a high plateau region. These sediments are slightly reddish grey in color and are very dense when dry. When the river rises in April from the effect of the melting snow at the headwaters of the Grand and Green Rivers, the amounts of silt increase (112 to 374 parts in 100,000), most of it coming from erosion in the upper part of the river. As the spring floods subside the amount of silt again decreases to about 122 parts in 100,000.

All of the silts are rich in phosphoric acid and potash, but are at

[3] Bull. 44, Ariz. Exp. Sta.

[4] Irrigation in Imperial Valley by C. E. Tait.

present mainly valuable for the nitrogen which they contain. This is more especially true of the silts coming in the summer floods which carry the washings from large areas of grazing land. As nitrogen is the element most lacking in the valley soils these silts have a distinct fertilizing value from this element alone. From the standpoint of soil fertility, therefore, these sediments comprise a complete though not a balanced fertilizer and should be welcomed. They will ultimately bear somewhat the same relation to the fertility of the valley soils

Fig. 10.—Silt deposited behind a diversion gate.

as do the Nile sediments to Egyptian soils. Wherever this condition exists in older countries, such as parts of China, Japan and Egypt, the silt is utilized with the utmost care.

From a mechanical standpoint the sediments are often considered a nuisance by many farmers. The first trouble arises in the maintenance of ditches, as a large amount of silt is deposited before it reaches the fields. Considerable work has been done by the California Development Company in devising apparatus for clearing the large canals. This is now being done with a fair degree of success. (See Fig. 11.) The farm ditches are are universally cleaned with V's. There is no way at present for overcoming the accumulation of silt on the ditch banks after cleaning, although the problem may be solved in the future by constructing a system of drain ditches parallel to the distributing system, with grade enough to carry away the accumulation of silt as

well as to afford general drainage for the country. At present no special trouble has been encountered. In Egypt this same condition has existed for many centuries.

Forbes[5] has calculated from tests (which extended over twelve months) of the Colorado River water at Yuma, that if four feet of water is used on the land in one year, twenty-three one-hundredth (.23) of an inch of soil will be added to the land. This is supposing, of course, that all of the silt carried by the water will reach the land. As a matter of fact, however, a large part is dropped in the canals and ditches.

The silt either in the ditch or in the field becomes extremely hard and brittle when dry. This varies with the character of the silt, the summer silts being less compact than the winter silts, although causing more trouble on account of quantity deposited. The fact that the particles are deposited in a very finely divided state and not in a floculated condition, is the cause for this hardness. By the natural processes of weathering, these hard crusts, if not too thick, are in time partly loosened and incorporated into the soil below. This process is greatly assisted by discing, renovating or cultivating the fields, thus breaking up the crusts and hastening the natural processes active in the soil. The difficulty of getting water into the soil on account of the impervious layer of silt is lessened by breaking up this crust as often as possible, not only to allow more water to get in but also to form a mulch to hold it there. The renovating of alfalfa is especially advocated as the silt crust is usually broken up and turned under in the case of most other crops. The silt collecting around the stems of young alfalfa often seriously injures it, especially at the head of the field where the silt deposit is the thickest. The silt acts beneficially in some cases in filling in holes or small depressions.

The Colorado River water is comparatively free from injurious salts even during low water periods, and the salts found in the largest quantities are of mild nature. The nitrates which are present in appreciable amounts have, of course, a fertilizing value.

The object in irrigating is, of course, to get water into the soil in the shortest possible time, as losses from evaporation are great. The productivity of a fertile soil, other conditions being favorable, is proportional to the amount of water present, provided there is no excess which would restrict the entrance of air to the roots. A plant uses from 225 to 900 times its dry weight of water and therefore the importance of proper moisture conditions cannot be over estimated.

[5] Arizona Exp. Station Bull. 53, p. 61.

As there is no ground water which can be used by crops in this valley, especial care should be taken to get enough water into the soil to supply the needs of a maximum production.

The number of irrigations and the length of each irrigation depends upon the character of soil and the method of applying the water. A sandy soil takes water more readily and less water is needed to meet plant requirements than in a heavy soil, but there is no general rule which can be applied to suit all conditions. In heavy soils where percolation is slow, irrigation should be more frequent than on sandy soils. In tests made it appears that about 13% of moisture is needed in these soils before ordinary crops can utilize any for their use. In sandy loam 7% is sufficient. The safest way to judge when land needs irrigating is to dig down at frequent intervals to determine roughly the amount of moisture in the soil by pressing it in the hand. Another convenient method is by using a soil auger. A more accurate test of seepage from furrows can be made by digging a trench five to six feet deep and setting a perforated basin of water near the rim, so that water can leak out gradually and soak into the soil. The depth of penetration can be noted on the wall of the trench.

Ranchers in the Imperial Valley sometimes forget that there is no ground water on which to depend and consequently all the water must come from the ditch. Mistakes are often made because the soil conditions are not investigated and this is especially true of persons coming from other parts of the State where sub-irrigation may be counted on. In one case which recently came to our notice, a large vineyard was dying in spots, the owner thinking that some disease had attacked his vines. Upon examination, however, it was found that the soil below twelve inches was in a dust dry condition and the vine roots were confined largely to the surface stratum. Thorough irrigation in deeper furrows with a small stream running for a much longer time wet the soil deeply and restored the vineyard. Good results will undoubtedly be secured by using furrows from 8 inches to 12 inches deep, as the water would soak in deeper and the loss through surface evaporation would be greatly lessened.

But while irrigation is the all important operation in the Valley, it may easily be overdone. Plants may be drowned out as well as dried out, hence care must be taken not to allow an excess of water to collect. This is especially true in the light soils which overlie heavy clay where percolation is slow. In tests made on some soils of this nature it was found that the soil above the clay was nearly saturated, but the fact that there is no general ground water level at present prevents, in most cases, a rapid saturation of the soil.

If the soil be oversaturated, however, not only will the excess of water be detrimental, but there is almost sure to be a rise of alkali from below forming an accumulation of salts near the surface. Wherever water accumulates and stands on the surface at the lower side of the field, outlets should by all means be put in to carry the water into some lower ditch. Such outlets if carried under the roads would effectually put a stop to much of the accidental road flooding which has proved such a nuisance in the past.

Fig. 11.—V-shaped crowder used for cleaning the silt out of lateral canals.

The methods of applying the water are much the same as in other irrigated sections. The land must, of course, be properly leveled and this, in the case of dune sand areas, sometimes entails considerable expense. It is customary to plant newly leveled land to barley in order to have an opportunity to observe the flow of the water for one year and correct any unequalities before a permanent crop such as alfalfa is planted. While flooding is, of course, the only practical way of irrigating grain or alfalfa, it is less efficient than furrow irrigation for the reason that when the entire surface of the soil is covered with water, the air in the soil does not escape as readily as it does between the furrows in furrow irrigation, and consequently tends to hold the water out. Neither can flood water be held on the land as long on account of the danger of injuring the plants by scalding. After irrigation the evaporation from the bare surface is rapid. The loss from evaporation is less where the ground is covered with a heavy growth.

If a silt crust has been formed and not well broken up, the water soaks through slowly and consequently the irrigation, although apparently thorough from a surface view, is really unsatisfactory. Flooding by the use of borders or basins should be used where alkali shows up on the ridges in previous furrow irrigation. Flooding will wash the salts down and distribute them more evenly in the soil and if the sub-drainage is good will carry the salts away entirely.

Furrow irrigation is used for nearly all crops other than alfalfa and barley. This is the ideal method of applying water under ordinary conditions, as it adds the moisture without wetting the whole surface and without allowing the water to come into close contact with the plants. It has been repeatedly demonstrated that deep furrows will distribute the water more evenly and more quickly than shallow ones and less surface is moistened. A small stream run for a longer time seems to give better results than a larger stream for a shorter time. The length of the irrigation, however, depends upon the rate or percolation, which can only be determined by tests in each case. When furrows are far apart, as is the case in many vineyards, care should be taken to see that moisture reaches between the rows, especially on the harder soils. In tests made on loose sandy loam five weeks after irrigation, the moisture content was about 9% greater underneath the furrow than in the row at the same depth. In harder soils it is apt to fail to soak through and meet between the rows.

GENERAL STATEMENT OF INSECT PESTS AND DISEASES.

It would seem that the Imperial Valley, being a new country made up entirely of reclaimed desert, presented a remarkable opportunity for the development of an agriculture free from insect pests and diseases. Realizing this, an efficient county horticultural commission was early organized and has done good work in inspecting all nursery stock brought into the valley. It has been found, however, that no amount of caution will suffice to exclude all of the undesirables. The codling moth of the apple and pear, for instance, is brought in in the cracks and corners of apple boxes and it is only a question of time till the apple and pear trees will have to be sprayed if fruit free from worms is produced.

On the other hand, the scale insects which are disseminated on nursery stock may be excluded by thorough inspection and destruction of all infested stock. Thus the money spent for inspection work may be saved to the county hundreds of times over in the much greater profits resulting from clean orchards. Perhaps the most damaging group of insects in the valley at the present time are the aphids or plant lice.

These work great harm to the cantaloupe crop, and on cabbages and cauliflower they are sometimes serious enough to turn an otherwise successful crop into a failure. Several species of thrip have caused damage to crops, notably alfalfa, cotton, and onions. The grape-vine leaf hoppers appeared in 1909 for the first time in damaging quantities. So far no grape phylloxera is known in the valley nor any of the *Alorhina mutabilis* beetle which is so destructive to figs, peaches and grapes in Arizona.

Among fungous and bacterial diseases we find that those which attack the above-ground parts of plants are few and do but little damage. Parasites, such as asparagus rust, celery blight, grape mildew and pear blight can scarcely endure the hot sun and very dry air. Soil fungi and bacteria on the other hand, such as crown gall and fusarium diseases of the roots of plants may be expected to become unusually troublesome.

The most important pests are discussed separately under each crop.

VARIETIES BEST ADAPTED TO THE VALLEY.

It is a well known fact that environmental stimuli, such as climate, soil, elevation, and latitude, react very differently upon different varieties of plants and it follows that each climatological area has its own set of varieties which thrive and produce best under the existing conditions. One important phase of Experiment Station work is the testing of many varieties in the effort to determine those best suited to a given region. In the Imperial Valley the conditions are unique and we would hardly expect to find a large number of varieties brought in from other regions well adapted to the conditions. It therefore follows that in the Imperial Valley it is especially important to develop local varieties. The seeds of many kinds of fruit trees should be planted and the seedlings raised to fruiting in an effort to produce new varieties thoroughly adapted to the region. While such work falls naturally into the province of the Experiment Station, it is nevertheless an exceedingly interesting and in some cases profitable field for the individual who has a taste for plant breeding. Volunteer seedlings of fruit trees appearing about the home grounds should be protected until fruit is produced and its character noted. The fruits which offer special promise to the investigator along these lines are dates, figs, peaches, plums, almonds, apricots, apples, pears, pomegranates and perhaps blackberries, dewberries and strawberries. Among the ornamentals, roses and oleanders offer an interesting and promising field for work.

DISCUSSION OF CROPS.

(Arranged Alphabetically.)

ALFALFA.

Alfalfa is at present and probably will continue to be one of the leading crops of the Imperial Valley. Originating in Persia and Arabia before the dawn of agricultural history, this "Best Fodder," as the Arabic name signifies, has been associated for thousands of years with the hot and arid countries which border on the Mediterranean. On this account the extreme climatic conditions of Imperial proved congenial to the alfalfa and its culture proved successful from the start. The dominance of this plant is peculiarly fortunate for the valley, for it not only contributes to the soil nitrogen gathered from the air and thus supplies a serious need; but it sends its long roots deep into the soil, puncturing the various strata of clay and allowing more water and air to enter and ameliorate the soil. Alfalfa is therefore an ideal forerunner for the more delicate crops, such as vegetables and fruits.

The common variety which bears no particular name, but which was probably originally introduced from Chili, seems to succeed admirably. The Arabian alfalfa makes a much faster winter growth and is preferred for dairy cows on account of being more succulent. It is more tender to frost, however, and will not stand heavy pasturing.

Alfalfa succeeds on a wide range of soils but produces best on the soft and medium hard ground. As is usually the case in arid portions of the west, the soil needs no inoculation with nitrogen bacteria, as is necessary in humid and rainy sections of the eastern states. The necessary bacteria seem to exist in the soil already for the nodules on the roots usually appear without previous inoculation.

Land intended for alfalfa, having been properly leveled, should be plowed, harrowed and irrigated before planting. The seed should be planted, if possible, in October or November, in order that the young alfalfa may get some growth before sharp frosts begin. If planted in the spring the seedlings usually do not gain sufficient strength to withstand the hot summer well and it is very difficult to irrigate without scalding the small plants. The seed is usually broadcasted, although drilling gives slightly better results. Experience has shown that fifteen pounds of seed (from 12 to 20 pounds) will produce an ideal stand which is defined by the best growers as being from

twenty to thirty seedlings to the square foot, depending on whether the crop is to be pastured or cut for hay, or both. When broadcasted the seed is lightly harrowed in, the object being to cover the seed from one-fourth to one-half inch. Irrigation should follow immediately and in case a dry crust forms on the surface before the plants are up, it should be softened by another light irrigation. Further watering should be delayed until the third and, if possible, the fourth leaf has appeared on the seedlings. If watered before this the deposition of sediment from the water will cover the plants and a patchy stand will result. Bare spots are at once occupied by weeds which injure the quality of the hay and render the field objectionable as a pasture, Nurse crops have never been of any particular value in Imperial Valley and most of the alfalfa is planted without them. Barley is often sown in old alfalfa fields in the fall to supply winter feed.

After the stand is well established cuttings follow about twenty-six days apart. Two irrigations are usually given between each cutting. The best time to cut alfalfa for hay to be fed to milch cows is when the alfalfa is about $\frac{1}{16}$ in bloom. The older alfalfa, cut when the field is in full bloom or when the pods are being formed, makes good feed for horses. The leaves, which contain the best part of the crop, shatter badly when the hay is cut late and the hay does not contain as much protein at that period. The hay is often cut in the forenoon, raked in the afternoon and stacked the next day. Considerable loss is incurred from bleaching and excessive drying if allowed to stay in the field too long. The practice of pasturing alfalfa, which is common in the valley, tends to lessen the yield which could be obtained if cut for hay, but the cost for labor during the summer makes the increased returns questionable. The field is injured by tramping, weeds are scattered rapidly and much of the crop is lost through waste. A better way, when possible, is to cut the crop for hay and feed during the year, pasturing as little as possible. In any case the cattle should be rotated from field to field to give the alfalfa a chance to recuperate.

The best fields yield as high as two tons in a single cutting, while the average is about three-fourths of a ton, or the same as the general average for the State. The total yield, however, is much greater than in most other alfalfa sections on account of the unusually long season. The first hay is cut in the latter part of April or in the early part of May and the cuttings follow from four to six weeks apart, giving from five to eight cuttings per year.

During August the alfalfa ceases to grow as vigorously as during

the cooler weather and in winter remains practically dormant for three to four months, depending upon the season and the time of irrigation. It has become a common practice to allow the alfalfa to dry up in August because of its slow growth at that time, and because of the injury done by the larva of the yellow butterfly. Frost is never severe enough to do any damage beyond nipping the tender parts of the slight winter growth. When this does occur the field should be cut to allow the new growth to come more quickly.

It costs from three to four dollars to produce a ton of hay, the average price obtained on the market is six to seven dollars. Baling costs two dollars per ton. The loose hay can be sold to an alfalfa meal mill. The alfalfa meal may be secured for $13.50 per ton. Feeding the hay is, of course, the most profitable method of handling the crop, as all kinds of live stock do well on this feed.

Discing or renovating alfalfa fields which have become unprofitable is not as common as it should be. The fields, especially when pastured, should be renovated in the fall or winter and several times during summer. This is done by special spike-toothed disc harrows. Ordinary disc harrows are often used, set at a slight angle so as to split the crowns but not cut them entirely off. Wherever discing is practised the results are uniformly better. This discing breaks up and loosens the silt crust and establishes a mulch which allows air and water to penetrate the soil more readily. Some weeds also are destroyed and some insects killed.

So far, little effort has been made to harvest alfalfa seed, although conditions are very favorable. Several failures have been reported, while some good yields have been secured. The treatment of the alfalfa, especially regarding irrigation, is probably the cause of past failures. In Arizona where conditions are similar, the yield varies from 200 to 900 pounds per acre. The second cutting gives the best returns. Nine to ten weeks will mature a crop. Old well established alfalfa fields yield the best and largest amount of seed. The crop should not be given as much water as when cut for hay, as short, stiff straw gives the best returns. Water should never be put on when the alfalfa is in full bloom, but it is good practice to apply water just before the alfalfa is in bloom and again later on while the pods are forming. No rains occur which would spoil the seed, this being a great advantage over more humid sections.

Insects and Diseases.—Perhaps the most serious enemy to alfalfa in the Imperial Valley is a green caterpillar, the larva of a yellow butterfly, *Colias eurytheme*. This pest is becoming quite serious and

often destroys from one to two cuttings each year. This year an as yet unidentified bacterial disease has killed at least 85% of the caterpillars during July, damage to the alfalfa after this date being slight. It is thought that the presence of abundant irrigation water in some way increases the fatality of this disease. A *Tachinid* fly also attacks a certain percentage of the caterpillars, but does not seem to greatly lessen their numbers. Spraying or other ordinary combative measures are, of course, impracticable. A study of the development, seasonal history and economic importance of this insect is now being worked out by V. L. Wildemuth, of the U. S. Department of Agriculture, and W. E. Packard, of this publication. This investigation has not been completed, but judging from the work already done it would appear that a large proportion of the caterpillars can be killed by cutting the second crop of hay earlier and shorter than is the general practice, providing this is followed by a heavy irrigation with a large head of water, thus drowning the caterpillars, or by delaying irrigation for a few days, thus drying the field and starving them. By doing this many of the larvae would be prevented from maturing. This would, of course, lessen the number of eggs laid and the third brood would be reduced accordingly, this being the brood which does the greatest damage. Close and clean cutting will also assist in reducing the numbers of the pest, because by this method no food would be left for those caterpillars present to feed upon and consequently starvation would result. This statement, however, will apply only to Imperial Valley, as the results obtained may not apply to other sections.

The larva of a moth also appears in the latter part of the summer and does considerable damage. This worm closely resembles the caterpillar but is much smaller when grown. No remedy is known for this pest. The leaf hoppers occur in large numbers but so far have done little serious damage. A black species of thrips, *Anothrips nigra Osb.*, are numerous on the blossoms at all times but do little harm. The black spotted thrip, *Heliothrips facietus,* causes an appreciable loss in the leaves during the latter part of the summer. The spotted character of many of the leaves is caused by them. No remedy is as yet known.

The Chalsid fly attacks from 10% to 40% of the seeds and causes a serious loss. By fanning the seed, however, the poor ones can be blown out and a good quality of seed obtained. The same trouble occurs in other alfalfa seed sections, but nothing has been done to remedy matters.

Leaf spot attacks a good many leaves but is not generally very damaging. No root rot has been reported in the Valley as yet.

ALMOND.

In general, the climate of Imperial County is well adapted to almonds. The cool winters followed by warm, sunny and dry weather of blooming and setting time, seem to supply just what is needed for the best bearing of almonds. To be sure, an occasional late spring frost may kill the young fruits, but if the seeds have been well fertilized by pollen produced during dry, sunny weather it is surprising how much cold they will endure. The few trees which have been planted in the Valley have grown well, and although yet too young to judge as to productiveness, the indications are good. Older trees in the similar climate of Indio have produced well. A Jordan almond tree near Indio is said to have yielded 24 pounds which were harvested July 25, 1909, the tree being four years old. When the writer examined this tree in 1910 it was again loaded with fine fruit. Indications so far point to the following varieties as most suitable: Texas Prolific, IXL, Nonpareil and Jordan. The Texas Prolific should be planted in alternate rows with the other kinds to insure cross pollination.

As regards pests, very little can be said at present. The red spider may be expected, but is easily controlled by dusting with sulphur. It is quite possible that the crown gall, a bacterial disease which years ago almost destroyed the almond industry at Glendale, Arizona, may become serious enough to cause trouble in the Imperial Valley. This Station has for some time been conducting investigations directed toward the control of this disease. While it is wise for persons who contemplate almonds on a commercial scale in Imperial to keep in mind the possibility of crown gall, it would be foolish to allow this consideration to influence one against planting a few trees for home use and local markets.

APPLE.

The climate of Imperial is not well suited to the growing of apples. The summer heat, together with the very dry air and low altitude, make it a serious question whether apples will ever be grown on anything like a commercial scale. Only a few varieties can be expected to bear well and the trees are apt to fail early on account of sunburn, root rot and other troubles.

Still a small quantity of fair quality apples may be grown for home use. Some years there is a second crop of indifferent quality. It is very important to head the trees quite low and to prune so as to shade the trunks. As to varieties, the Bismark and the Red Astrachan have been reported as doing well, while Arizona experience indicates

that Gravenstein, Black Ben Davis and White Winter Pearmain would be promising varieties to test. It is quite possible that in the future local seedlings will be developed which will be far better adapted to the climate than any of the above mentioned varieties.

APRICOT.

Of all deciduous fruits, probably none are more at home in the climate of Imperial Valley than the apricot. The crisp, sunny winters and hot, dry summers seem to furnish just the conditions needed by

Fig. 12.—Newcastle apricots with cantaloupes between. Trees cut back to 24 inches from ground in February; photo taken on June 17th, following.

this fruit. Of course an unusually late frost may occasionally kill the blossoms of the Newcastle, but this is the exception rather than the rule. Up to the present time the acreage planted in Imperial Valley is much larger than that of any other tree fruit, there being 30,000 trees at present growing in the county. Wherever irrigation and cultivation have been attended to with even moderate care, the trees have made a fine growth and are bearing heavily. In some cases the trees begin to bear the second year. Ripening, as they do, at the time of year when the danger from rain is slight and the relative humidity of the air is very low, the alternative of drying the product (in case

the market for fresh fruit is not encouraging) is open to the growers. There is usually no trouble, however, in selling the early varieties fresh, for they ripen a week or ten days earlier than in the San Joaquin Valley.

Ripening dates for five of the principal varieties have been noted and (with some variation from year to year), are approximately as follows: Newcastle, April 20 to 30; Royal, May 5 to 15; Blenheim, May 7 to 20; Moorpark, May 15 to 22;, and Hemskirk, May 27 to June 5. The Newcastle and Royal are planted to a much larger extent than any others. The Newcastle being the earliest to mature brings high

Fig. 13.—Apricot trees four years old, Bixby Ranch, near Imperial.

prices, but is a notably poor shipper, and there is some danger of the planting of this variety being overdone. A new variety combining the earliness of the Newcastle with the good shipping qualities of the Royal is much to be desired.

The peach is probably the best stock for the apricot in Imperial Valley, although apricot root may prove equally as good. It is very necessary to head the trees low to prevent sunburning of the trunks. Irrigate copiously from January first until the fruit is set. Between that time and harvest water should be given sparingly, with thorough cultivation between irrigations. Some of the best growers prefer to prune twice a year, once in January to shape and train the tree and again after the harvest to check the too redundant vegetative growth.

ARTICHOKE.

The Globe Artichoke (*Cynara scolymus L.*), is a large, coarse growing, hardy, perennial vegetable which seems to be well adapted to Imperial conditions. It has been so little grown in the Valley that data concerning its productiveness and profitableness is lacking. The plant thrives exceedingly, however, and it is not unlikely that this may in future become a profitable crop. As a vegetable it is consumed in large quantities in France and other European countries, but in the United States it is but little known and the market is very limited.

The Jerusalem Artichoke (*Helianthus tuberosus, L.*), is a tall growing, sunflower-like plant which bears tubers which are appreciated by persons coming from the eastern and southern part of the United States. The plant thrives in Imperial and seems to produce a heavy yield of tubers, although actual records of yields are not obtainable. Eaten raw or made into pickles the tubers would be a valuable addition to the products of the home garden. The plant also has considerable value as a heavy producer of good quality hog feed.

ASPARAGUS.

The asparagus plant thrives wonderfully in Imperial Valley and the culture of this vegetable on a commercial basis has so far proven quite profitable. There is no cannery in the valley, as better prices can be obtained by shipping the entire crop in the fresh state. The crop should be grown on a soft, sandy soil in which the humus has been increased by the application of stable manure, straw or the turning under of a heavy crop of alfalfa. Seed is planted in the seed bed in April and the plants thinned to six inches in the row. In twelve months the plants (male plants preferably) are selected and set out in the permanent field in rows six to eight feet apart and two and one-half to three feet in the row. If the crop is well cultivated and irrigated cutting for market may begin in the fourth year. Cutting begins about February 15th and continues for about sixty days, or until the price falls too low for profit. The crop is irrigated about every four weeks after cutting until fall, when it is allowed to go dry. The stalks are cut, raked and burned in the field in the late fall or early winter and the soil well cultivated. Water to start the spring crop is applied about the first or second week in January. The cost of cutting, bunching, packing and hauling varies from 80 cents to $1.00 per crate. The yield varies, of course, but some of the best fields produce one hundred 24-pound crates per acre. Prices vary according to

Fig. 14.—Asparagus field at cutting time.

Fig. 15.—Recently irrigated asparagus field showing the silt deposited by the water.

the season, running from $2.50 to $15.00 per crate in the Chicago market. The average net profit per crate has in the past been from $1.50 to $1.75. Profits are reduced in some cases by heavy losses due to poor methods of packing and consequent decay. Experience has shown that the best prices are received for asparagus about three-fourths green. The shoots are brought to the packing house immediately after being cut and placed in an upright position, standing in shallow water. The heads should be kept dry to prevent decay in shipping. For long distance shipments they are packed in moss in boxes each containing twelve two-pound bunches. Icing the cars has proved necessary and at present several growers combine their product in order to secure car load rates and icing facilities. Conover's Collosal, Palmetto, and Early Argenteuil are the standard varieties. So far, neither the asparagus rust nor insect pests have been troublesome.

AUSTRALIAN SALT BUSH (*See under Salt Bush.*)

AVOCADO.

It is a question whether avocadoes can be grown commercially in the arid southwest. The frosts will probably prove too severe for them. It is possible, however, that an occasional tree may be successfully fruited for home use in a sheltered yard or a garden where protection may be given with a tent on the coldest nights of winter. Budded trees are much better than seedlings.

BANANA.

Bananas being native to tropical countries which enjoy heavy rainfall, are but poorly suited to Imperial Valley. Still an occasional plant may be successfully fruited if grown along a pond or a ditch where its roots may be continually in reach of water. Some protection from frost will be needed in the winter and the leaves will be badly torn to pieces unless protected from the wind.

BARLEY (*See under Grain.*)

BEANS.

Beans being sensitive to the dry air as well as to the frost are grown with some difficulty. A spring crop of bush beans planted in late March will often produce a fair crop before being killed by the heat of June or July. A fall crop planted in early September will often yield satisfactorily, provided the frosts are late. Beans planted in spring will sometimes live through the summer and produce well

in the fall, although fall planted beans give the best results. In general, the crop is uncertain and is grown chiefly for home use and local markets. For snap beans to be cooked green, the earliest maturing varieties should be selected. Little accurate information as to the comparative merits of different varieties is available. The following, however, may be expected to give good results: Early Pink, Long Yellow Six Weeks, Kentucky Wonder, Golden Wax and Bush Lima.

The Soy Bean is well suited to Imperial conditions and should be planted extensively as a green manuring crop and as a forage and

Fig. 16.—Soy beans growing near Brawley.

grain plant. It attains a height of two and one-half feet and produces an abundance of seed. Being a legume it adds to the soil the much needed nitrogen. It thrives during the hottest weather of summer and is suited to follow and precede winter crops.

Seed may be planted at any time after the middle of April. The seed of some of the experimental plantings was destroyed by the larva of a small beetle (*Vacusus confinis*) before germination, but other plantings in the valley have done very well. The plant will endure a little frost and ripen several weeks earlier than the Cowpea, thus having a wider range of planting time. The soy bean is quite drought resistant, being almost equal to kafir corn in this respect.

The Velvet Bean has been tried both in Arizona and Imperial Valley, but so far has proved a failure.

BEETS.

All kinds of beets do well in the valley when grown during the cooler parts of the year. As yet, however, none have been produced on a commercial scale. Beets are sensitive to heat and are somewhat stunted by sharp frosts. It often happens that beets checked in growth by frost go to seed at the approach of warm spring weather. The Klein Wanzlebener and the Early Blood Turnip are the varieties commonly planted. The seed may be planted either between the 15th of September and the 15th of October or in February. They do fairly well on all soils but give best results on the medium types. On hard soils the roots are apt to be short and poorly shaped and on this account they should be irrigated often enough to keep the soil from baking too hard about the roots. Beets are fairly resistant to alkali.

Mangels are successfully grown, although their habit of standing higher out of the ground makes them more sensitive to heat.

A kind of beet known as Swiss Chard, which is grown as a salad plant for its succulent leaves, thrives and produces well in the valley.

Sugar beets have been tested on nearly all types of soil in the valley by Mr. H. Egge, of El Centro, and have proved to be adapted to the locality when grown during the cooler parts of the year. According to his results, spring planted beets were a failure, the best month for planting being November. The sugar content of the juice in the November plantings ran as high as 20%, the average being from 13 to 14% in the beets. The ground should be plowed deeply, cultivated, and well irrigated before planting. The best method tried so far has been to furrow out the field eight feet apart and run the water until the soil is well saturated, then level and cultivate as soon as as the horses can get on the land. The seed should be drilled in rows 16 to 18 inches apart and later thinned to 6 to 8 inches in the row. Usually two rows are planted on one ridge.

There is a plan at present to begin the culture of sugar beets for shipment to the factory at Glendale, Arizona, and if this should prove successful there is the possibility of a factory being established in the valley. The beet leaf hopper has caused some blight in the test plots and slight damage has been done by a fungus. A small undetermined beetle has caused a scarring of some of the beets. No remedies for these insects have been tried. In some locations beets are damaged by the spring winds and windbreaks would be advisable in such cases.

BERSEEM.

This is a forage and cover crop largely grown in Egypt. It is poorly suited to Imperial Valley because it is sensitive both to the frosts of winter and the heat of summer. It is therefore unable to reach its full development. If planted about the first of September it often gains sufficient strength for the roots to go through the winter and to make some growth in spring. On account of its limitations, the crop is not recommended for general planting.

BLACKBERRY.

Some varieties of blackberries grow thriftily and produce very well when given proper care. They seem to delight in the heat of summer and produce a tremendous growth of canes which should be cut back considerably after the crop is harvested. They require an abundance of water. Only small patches of blackberries have so far been attempted, but some of these have proven quite profitable. The Crandall's Early or California Everbearing is perhaps the most successful variety so far tested.

Loganberries do not seem so well suited to the climate as blackberries and are grown with difficulty.

BROOM CORN (*See under Sorghum*)

BUCKWHEAT.

This plant is suited to the cool, moist regions in the east and is therefore quite out of place in Imperial Valley. It is injured both by the cold and heat and therefore has small opportunity to mature.

CABBAGE.

The cabbage belongs to that class of plants which will endure the winters but succumbs to the heat of summer. Cabbages are therefore grown in the winter and succeed admirably. They should be planted on soft soil. An application of stable manure will greatly increase the yield. The seeds should be planted in succession from August to October and the plants raised under the partial shade of a lath shelter. In some cases good results have been secured by planting the seed directly in the field. They may be set in the field in October and November. A constant and plentiful water supply is essential. The crop is harvested from February to late in May and shipped mostly to Los Angeles. Of late years an aphid, known as the cabbage louse, has been very destructive and proves a difficult pest to overcome. It has been found that by setting out very large plants in October and

encouraging a rapid growth many of the plants will succeed in spite of the lice. Spraying with kerosene emulsion, soap solution, or with a tobacco spray gives good results if practised in time. Burning infested plants aids in preventing the spread of the pest. Grasshoppers do some damage to plants set before the middle of September. A small worm known as the cabbage plusia is common in the spring and works some damage. The sprays mentioned above are recommended for this worm.

All of the varieties so far tested in the valley have been reported as satisfactory.

CANTALOUPE (*See under Muskmelon.*)

CARROT.

Carrots grow well and yield heavy crops when grown in the soft land of Imperial Valley. They should be planted in the fall and grown during winter.

CASSAVA.

Very little data on Cassava is available. Some attempts have been made to grow the plant in the valley but while the Cassava is a tropical plant, it does not endure well the severe dryness of the air nor the frosts of winter. It is possible that more hardy varieties may be introduced which would make a successful growth under Imperial Valley conditions.

CASTOR BEAN.

The Castor plant seems peculiarly suited to the climatic and soil conditions of the southwest in general, and to the Imperial Valley in particular. In fact, the Castor bean is typical of the region. The plants live to a great age and if properly pruned attain the proportions of small trees. The quick growth and large leaf area of these plants make them very valuable around the house for screening outbuildings and for cutting off objectionable views. They are very resistant to alkali and will grow in almost any kind of soil, provided water is supplied them. They are very suitable for securing a quick and temporary shade in poultry yards while permanent shade trees are growing.

Seed planted in April will often produce plants ten feet tall by October. Some of the large leaves are lost during the frosts of winter but the shoots are seldom killed back more than a few feet, active growth beginning again with the first warm weather of spring.

Heavy crops of seed are produced but the labor involved in harvesting them and the low price offered make the crop unprofitable to

grow on a commercial scale for the oil. Some people object to them on the ground that the seed are poisonous and may be eaten by children, but it may be said on the other hand that the child who relishes these seeds is a rarity indeed!

CAULIFLOWER.

We have been unable so far to obtain much data on Cauliflower in the Imperial Valley. Its culture has not yet been attempted on a commercial scale. Judging from a few plants raised in home gardens, we would expect cauliflower to produce well if planted in the fall and treated like cabbage. Being more sensitive to unfavorable conditions than cabbage, its successful culture requires more skill. Some persons state that they get better results with cauliflower by planting the seed in the permanent rows and not transplanting. It is subject to the same plant lice as cabbage. The Early Snowball variety is said to have produced fine heads. Very likely other varieties would do equally well.

CELERY.

For the best development of the celery plant, a cool moist climate is required. For this reason celery will never be grown on a commercial scale in the Imperial Valley. Those who wish to produce a small amount of celery for home use may do so, however, by planting the seed in January or February in a shaded bed in a cool place where the soil may be kept constantly moist. The plants may be set out in the garden in September or October and shaded with brush until they obtain a start. The crop should be ready to harvest in December and January.

CHERRY.

All varieties of cherries are so unsuited to the climatic conditions of the region that they are out of the question as a commercial crop. Some few trees of different varieties have been planted and they have made some growth but little or no fruit has been produced.

CITRON.

The Citron of Commerce is a citrus fruit which is too tender to frost for the Imperial Valley, except perhaps in the most protected places. Candied citron has in the past been produced more cheaply in Europe than in this country, hence, with possibly one exception, citron trees are grown in California mostly as curiosities.

CLOVERS.

As alfalfa takes the place of all clovers except perhaps for lawns and cover crops, there is no particular reason for growing the clovers except for these purposes. The intense dry heat of summer injures all the clovers which have been so far tried in the valley.

White Clover if given plenty of water makes a fair lawn but does not compare with lippia in value for this purpose.

Burr Clover grows well during the winter but does not make enough tonnage to warrant its use as a cover crop.

Sour Clover (*Melilotus indica*) makes a vigorous growth between early fall and late spring and is one of the best known plants to date for orchard cover crops and green manuring.

CORN (*Maize or Indian Corn.*)

A number of varieties of field corn have been tested in the valley with only partial success. Most of the corn brought from the east has not proven to be adapted to this climate, but certain varieties, namely Mexican June and Hickory King, have produced fair yields, from 40 to 50 bushels being sometimes secured. The stalks often grow very high, especially when over-irrigated, and usually have two ears to the stalk, which is considered to be an average. The Arizona Experiment Station reports[6] that certain varieties of flint corn, especially the Kellogg and Blue Squaw, from western Kansas, have done well under Arizona conditions. The corn produced is of good quality and the ears are of fair size and well filled, provided the seed is planted in the latter part of the summer. There is a big opportunity for developing a variety of corn which will be better adapted to this region than any now grown.

The hot dry weather during the late spring and early summer prevents proper pollination, as the silk dries up before it is receptive. On this account, if planted in the spring, the cobs will be barren or nearly so. If planted during the latter part of July or even the first part of August the corn escapes the period of driest air and will mature before damaging frosts occur. The corn in this way can follow cantaloupes, barley or other spring crops. If planted by the first of August, roasting ears may be plucked by the last of September. The seed is drilled in rows from 3 to 3½ feet apart and not checked as in the east. The soil is well soaked before planting and another irrigation given after seeding. Subsequent irrigations follow when needed to

[6] Bull. 54, Ariz. Exp. Station.

keep the soil in a good moist condition. A cultivation should follow each irrigation. Three or four good irrigations will often mature a crop. Furrow irrigation is much preferred to flooding.

A black flea beetle injures the young corn in the spring, but if the seed is planted in the latter part of July, as is the only safe method, these beetles will be avoided. The corn ear worm does some damage to a good deal of the corn, especially to the eastern varieties which have been tried. The Mexican June corn has a thick and tightly wrapped husk which prevents much damage to that variety. The Mexican June is, however, difficult to husk on this account.

Sweet Corn.—The field corn raised is often used as sweet corn and if picked at the right time is fairly good. Most varieties of sweet corn will grow well if planted in the latter part of July, as recommended for field corn, but much of it is attacked by the corn ear worm.

Pop Corn.—Pop corn has been tried on a limited scale and has produced well. The general treatment for this corn is the same as for field corn. The Pearl and Rice have both made good growth, the Rice giving slightly better results.

COTTON.

It has been long known that parts of southern California were well adapted to cotton culture but on account of the unfavorable economic conditions no commercial crops were produced until 1909, when 1,500 acres were planted in the Imperial Valley. The results secured were so encouraging that 15,000 acres were planted in 1910. The climate of this section is especially adapted to the growing of cotton, for the long growing season allows many bolls to mature, the almost total absence of rain storms in the fall allows the crop to be harvested in first class condition and in the opinion of the writer fewer squares drop during the growing season, thus increasing the number of bolls set. There is no doubt but that much greater yields can be obtained under irrigation, with the favorable climatic conditions of the Imperial Valley, than in the south where moisture is supplied by rainfall only.

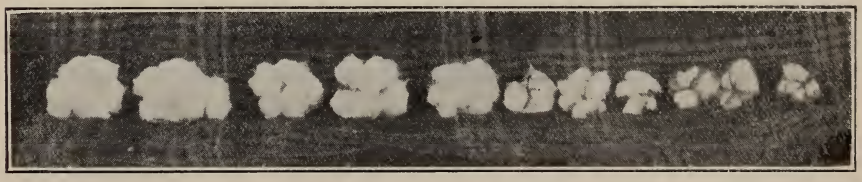

Fig. 17.—Variation in size of cotton bolls, each from a different plant of same variety, showing great need of systematic selection of seed.

The best cotton has been grown on the medium hard soils. The hard soil did not give good results in many cases because of the difficulty in properly preparing the seed bed and also because proper root development was retarded by the lack of thorough irrigation. This statement, however, does not apply to all hard soils. The experience varies greatly in regard to the soft soil, some excellent results being reported from some farms and some failures from others. The lack

Fig. 18.—Imperial Valley cotton field.

of nitrogen in some of the soft soils, together with the damage caused by a temporary water shortage, undoubtedly accounts for many of the partial failures. Cotton makes a heavy demand on the nitrogen in the soil, and if continuous crops are grown without rotation with some leguminous crop and the seed sold off the land, it is certain that in a few years this element will have to be supplied in the form of a commercial fertilizer.

Cotton culture under irrigation has proved a new thing for American planters, so they have had to look to Egypt for methods of culture, rather than continue those common in the southern States. The best methods of irrigation and general treatment of this crop are therefore uncertain and good results should increase with improvement in this line.

The time of planting at present varies from the cessation of frost until the first part of July, the best time being between March 15th and

April 15th. Early planted cotton is the most profitable, as it has the advantage of a longer season of growth and the first crop is ready to pick when pickers are less in demand.

In preparation for the seed, the land is generally plowed, harrowed and furrowed out four feet apart. Water is then run in the furrows until it soaks through and meets between the furrows. As soon as dry enough to work, the land is again harrowed to form as much of a mulch as possible, and the seed planted on the ridges with the usual one-horse cotton drill. Twenty pounds of seed are planted per acre. This is sometimes followed by a light irrigation and as soon as the plants are well started they are thinned to from 18 to 24 inches in the row. Cultivation should follow and should be carried on as continuously as possible. No water should be applied until the plants show a need, as much as possible having been put into the soil before planting. The best cotton has been produced where as little water as possible was applied after seeding, until the plants get well started. After this, water is applied often enough to maintain uniform moisture conditions in the soil. This is important for the cotton plant is impatient of drouth. Furrow irrigation is much more efficient than flooding. Each irrigation should be followed by a shallow cultivation, deep enough to form a good mulch but not deep enough to injure the surface roots.

Level planting has proved very successful in some cases, especially on soft soil. The land is flooded and thoroughly harrowed and the seed planted before furrowing. The mulch thus obtained prevents excessive evaporation and the young plants do not require irrigation so soon. When water is needed the field is furrowed. This reduces the expense and partially prevents the rise of alkali on the ridges. In any case the land should be leveled and flooded after the stalks have been removed, to distribute the salts through the soil.

The yields have varied widely in different fields and under different methods of treatment, but from a bale to a bale and a half, some cases two bales, have been produced per acre on the fields that have been well handled. In order to maintain the standard and yield of the cotton grown in this section, much more attention must be given to seed selection. The cotton now largely grown in the valley is undoubtedly superior to any of the other varieties tested, and careful seed selection is far more important than the trying of new varieties. If seed is carefully selected, not only the yield but the quality should be improved upon.

The variety most generally grown is the Mebane Triumph, a big

boll, storm proof, upland cotton from Texas. A large number of varieties has been tried, but so far none have proved equal to the Mebane Triumph. Several varieties of long staple upland cotton have been tried but there is a question whether or not this cotton will be successful on a commercial scale. Sea Island cotton has been tried experimentally, but the bolls do not open well. A great deal has been done by the agents of the U. S. Department of Agriculture in testing Egyptian cotton in an effort to establish this industry in the United

Fig. 19.—Cotton pickers at work.

States. Yields of over a bale to the acre have been secured. The quality and yield have been improved greatly by selection. It is hoped that in the near future Egyptian cotton can be made to yield crops profitable to the planters, as the Arid Southwest is the only part of the United States in which superior quality, long staple Egyptian cotton can be raised successfully.

The fact that the valley is free from boll weevil is, of course, a big advantage and every effort is being put forth by the County Horticultural Commission to prevent the introduction of this insect.

A thrip (*Heliothrips facictus*) does some damage to the leaves, causing a part of them to turn brown and fall. A new and peculiar bacterial or physiological disease affects the seed and a part of the lint while the bolls are yet green. This disease is undoubtedly not traceable to the water shortage, as is generally supposed. These troubles will be investigated by this Station as soon as facilities are available.

COWPEAS.

Cowpeas are well adapted to this climate, making a vigorous growth during the hottest parts of the year. Several varieties have been tried out on the medium hard soil and all made a fairly good growth. Some varieties, namely the Whippoorwill, New Era, Clay and Early Ram's Horn, produced the greatest amount of green matter per acre and should be planted extensively in rotation with other annuals as a green manurial crop, or used as a cover crop in the orchards. Alfalfa, however, will give better results as a green manure crop when it is possible to let it get a sufficient growth before plowing under. When a quick growing summer cover crop is needed the cowpeas will do well, especially when plenty of water is available. They are planted any time after April 1st, in rows 2½ to 3 feet apart and 2 to 4 inches in the row, on either the medium hard or soft soils.

CUCUMBER.

Cucumbers grow and produce well when planted either in the spring or fall. If well matured the vines may live through the hot weather of summer, although they produce very little good fruit during midsummer. The spring crop is planted during March, while the fall crop should be sown in September. The White Spine is a standard variety which produces well.

CURRANT (*Ribes rubrum.*)

Currants will not thrive in the hot dry climate of Imperial Valley. They reach their highest development in cool, moist localities, for the wild currant is typical of the undergrowths of forests in the east. For this reason it is hardly worth while to attempt to grow them in the arid southwest. The above applies only to true currants (*Ribes rubrum*) and not to dried seedless grapes which are sometimes erroneously called currants.

DATES.

Perhaps no crop now growing in the Imperial Valley has had as much scientific investigation expended upon the question of its adaptability to the conditions there as has the date. The Department of Agriculture at Washington and the Arizona and California Experiment Stations have taken a peculiar interest in the establishment of date growing in the arid southwest. Six years ago Dr. W. T. Swingle made the prophesy that the Imperial Valley was peculiarly fitted for the production of high quality dates and subsequent developments have proven his prophesy correct. While the date palm flourishes

best where the summers are very long and hot and where the air is exceedingly dry, it is also able to endure a good deal of frost, much more in fact than may be expected to occur in the Imperial Valley. While

Fig. 20.—Young Deglet Noor date tree showing numerous off-shoots and immature fruit.

there are a number of palms which ripen excellent fruit in the Imperial Valley, at present the industry is not on a commercial basis, chiefly on account of the great difficulty in securing offshoots of desirable varieties.

For proper development, the date palm requires long, dry and very hot summers, together with a fertile soil and plenty of water. It ripens its fruit to best advantage where the relative humidity of the air is very low during harvest time. It endures a great deal of alkali and will grow well on soil unsuited to other crops. A few offshoots each of nearly two hundred different varieties have been imported by the U. S. Department of Agriculture from the date producing regions

Fig. 21.—Young seedling date bearing fruit.

of the Old World. These have been grown and tested by the Arizona Station at Tempe and a number of them are producing successfully, but as these plants produce only one or two offshoots a year each it is easily seen that a number of years will necessarily elapse before sufficient offshoots will be available for planting out any considerable area of ground.

While waiting for more plentiful offshoots of the most promising varieties, such as the Deglet Noor, Tadala, Itima, Maktum, Halooa, Horra and M'Kentichi Degla, date seeds should be planted in the hope of securing desirable kinds. It is quite probable that some seedlings

may originate in the region which may be even more satisfactory and profitable than any of the imported varieties. Dates of course do not come true from seed and about half of the seedlings will be males. While it may not be profitable to plant a large acreage to seedlings, some space may easily be found about the home grounds or along roadsides and ditch banks for growing a few trees, especially as they have considerable value as ornamentals. For this purpose it is poor policy to plant seeds from imported dates bought in the stores. Such dates may have been pollinated by the Arabs with pollen from wild and worthless palms and the seed would of course possess this undesirable heritage. It is better to use seeds which have been grown in this country and pollinated from male palms which have sprung from good dates. In this way the probability of worthless seedlings is decreased from one-half to one-fourth. Most male seedlings will show some bloom before they are very large and may be destroyed as fast as their sex is disclosed by the flowers, thus leaving more room to the females.

It is expected that a more exhaustive report on dates will be published by this Station before the plantings assume large proportions.

DEWBERRY.

Dewberries, particularly the Gardena variety, produce abundantly and the fruit is of excellent quality, both as to size and flavor. The Gardena is harvested during the first two weeks of May. Vigorous roots planted in the fall on Imperial loam or sandy loam will often produce good crops the following spring. In fact, the fruit is produced in such quantities that it may prove profitable to grow them for shipment to northern markets. The practicability of such shipments, however, has not as yet been thoroughly determined.

EGGPLANT.

This vegetable is quite tender to frost but decidedly resistant to heat. The plants flourish in this climate and the fruit matures from the middle of May through the summer, provided an abundance of water is given. The seed may be planted under a protective covering in January and the seedlings transplanted once in protected beds to make them stocky and strong. When there is no longer danger from frost they may be set out in the field. The Mammoth Improved Spineless has been reported as producing well and we presume that other varieties also would succeed.

EUCALYPTS.

There are almost a hundred different species of Eucalyptus growing in California at the present time. The various kinds differ tremendously among themselves as to their ability to withstand extremes

Fig. 22.—Eucalyptus rostrata growing in pasture as a shade tree.

of climate, such as frost, heat and dryness. Some kinds endure low temperatures, but little heat; some endure great heat but are tender to frost. While almost all kinds flourish near the coast in southern California, only a very few are adapted to the peculiar climatic conditions of the Imperial Valley, and hence many failures and much

disappointment will result unless due care is observed in the selection of species.

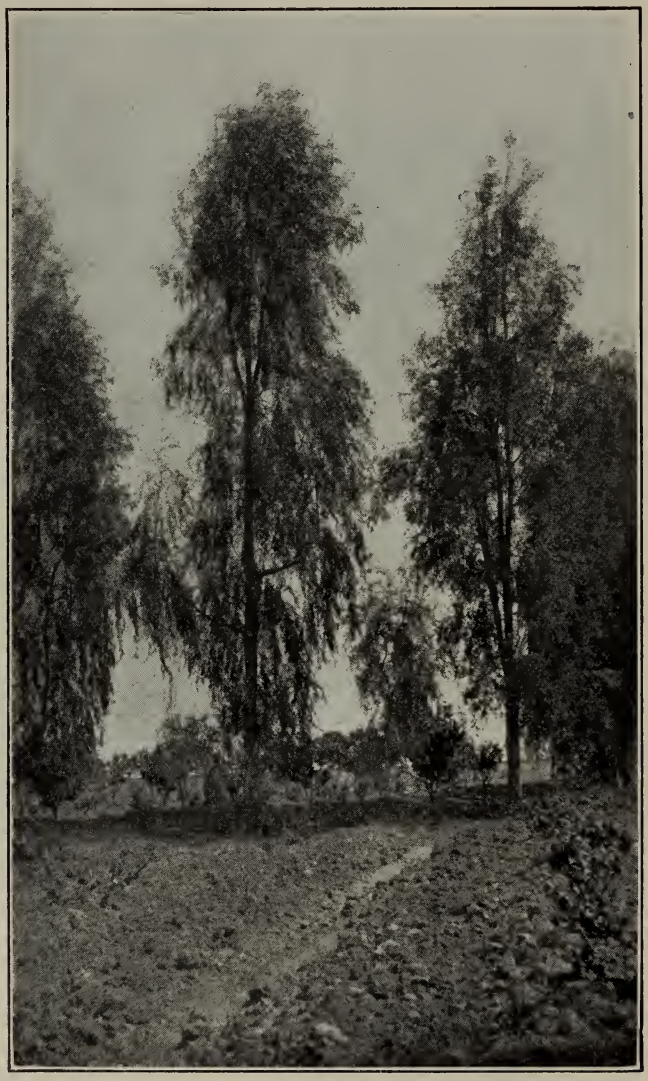

Fig. 23.—Eucalyptus rostrata seven years old.

Judging from past experiences, we may say that of the kinds tested the following may be expected to grow and endure the conditions fairly well: forest gray gum (*E. tereticornis*), red gum (*E. rostrata*), desert gum (*E. rudis*), white gum (*E. leucoxylon*), manna gum (*E.*

viminalis), red box or Australian beech (*E. polyanthema*), narrow-leaved iron-bark (*E. crebra*), and swamp mahogany (*E. robusta*). Of these, the most valuable and satisfactory for general planting in the Imperial Valley are in the order named: *E. tereticornis, E. rostrata, E. rudis,* and *E. viminalis.* More thorough testing in subsequent years may change the order given or even add other species to the list. The list is given more as a summary of present indications than as a final verdict.

There is certainly no doubt that *E. tereticornis* flourishes and makes a rapid growth under Imperial conditions, and it is highly desirable that it should be planted to a much greater extent than at present. In a naturally desert and treeless country it will prove of great value for fence posts, for fuel, and for many other purposes for which durable hardwood timber is used. There are offered for sale two types or varieties of *E. tereticornis,* the broad leaved and the narrow leaved. The narrow leaved type, *E. tereticornis var. linearis,* is much the best kind for planting in Imperial and in making purchases this variety should be insisted upon.

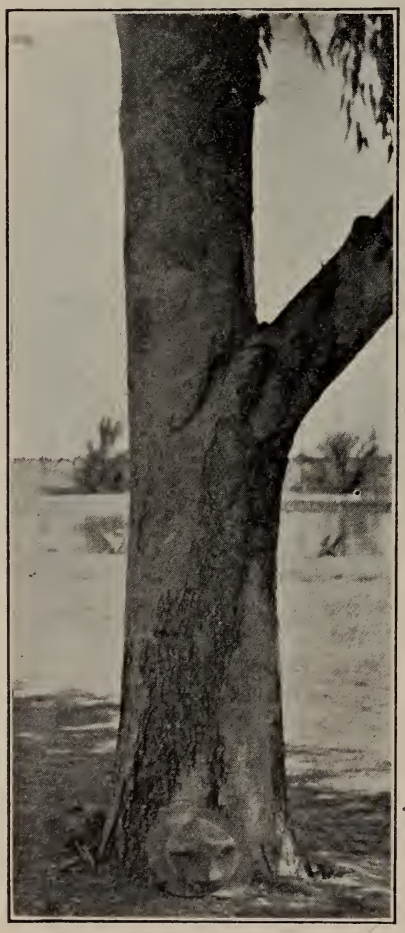

Fig. 24.—Trunk of Eucalyptus rostrata seven years old.

Eucalyptus trees are propagated exclusively from seed and the young plants are set in their permanent places in February or March when from six to twenty inches high. While some kinds are more resistant to drouth than others, it is hardly necessary to add that the growth of any kind of Eucalypt in the Imperial Valley is dependent upon irrigation water. When first set out they should be watered once a week, three furrows to the row but after the first year one furrow to the row and one irrigation every four to six weeks should be sufficient.

FIGS.

Fig trees of many varieties make a luxuriant growth and bear heavily in the Imperial Valley. Accurate data on the comparative merits of the different varieties is very meagre. The Mission, White Adriatic, Brown Turkey, and Black San Pedro are known to produce

Fig. 25.—Four-year-old fig tree on the S. M. Bixby ranch near Imperial.

well wherever they receive sufficient water and a reasonable amount of care. The Smyrna class of figs grow well, but it is necessary to maintain a colony of *Blastophaga*, or fig wasps, on Capri fig trees and pollinate the Smyrna trees artificially in order to secure a crop.

While the fig is highly successful as a fresh fruit for home use and for local markets, its possibilities as a dried product on a commercial scale are not known. Very little experimenting has been done up to date. The relative humidity of the air varies much in different seasons. Some seasons the humidity has been such that some difficulty

has been experienced in drying them. In other seasons it has been so dry that some varieties, such as the White Adriatic, have been reported as drying on the trees before fully mature.

There are no known serious pests of the fig in Imperial Valley. The large green beetle, known as the "Fig Eater" (*Allorhina mutabilis*) which is so destructive in the Salt River Valley of Arizona, has not yet gained a foothold.

FLAX.

Flax has only been grown in a small experimental way and very little is known as to its possibilities. Being a crop which is better suited to the north it is quite sensitive to the summer heat and should be planted in October and harvested for seed or fibre in the spring.

GOOSEBERRY.

It is very doubtful if gooseberries can be grown in the Imperial Valley with profit, as they are not at all suited to the climatic conditions.

GRAINS.

Barley is the principal grain crop of the valley. It is better adapted to a warm climate than any of the other grains, although the hot weather rather than the cold is the limiting factor in its growth. The yield varies from 8 to 25 sacks per acre, averaging from 12 to 15 sacks per acre. It is grown for grain, for winter pasture, and for hay, the usual practice being to pasture the field in the late fall and winter (not later than February) and to then let it go to grain or hay. In this way it forms a valuable green feed when alfalfa is practically dormant. It is often planted in the alfalfa in the fall to furnish a supplementary winter feed. A good discing before planting the barley will insure a good stand and help the alfalfa. It is not considered very profitable when grown for grain alone, on a small scale, although it is planted on most of the raw land as the first crop, as it gives quick returns and can be planted before the land is perfectly or permanently leveled. As the valley settles up the barley fields will give way to more intensively cultivated and more profitable crops unless grown in a two-crop rotation.

Barley will not sprout during the very hot weather in summer, when the temperature remains above 110 degrees F. during the day, even when the proper moisture conditions are supplied. The seed is sown any time after the middle of September to the middle of February. If winter pasture is desired the seed is usually planted about the first of October. When grain alone is wanted the barley is usually

sown in the latter part of December or the first part of January. The grain ripens in May. Broadcasting the seed, followed by harrowing, is the common method of planting. From 20 to 40 pounds of seed is used per acre when sown in the early fall and from 40 to 75 pounds when sown in the spring or winter, since the spring sown grain does not tiller or stool as does that sown in the fall. The usual practice is to allow the land to reseed itself or volunteer after the first year, as the scattering caused by allowing the ripened grain to stand for a long time in the severe spring winds before harvesting leaves plenty of seed on the ground to come up after the fall irrigation.

The land is sometimes irrigated before planting but usually the seed is put in dry soil and then irrigated. The amount of water needed to mature the crop varies with the different soils. Usually five irrigations are sufficient if given at the proper time.

Oats have been tried but have never proved to be a great success, mainly because they are more adapted to a colder and more moist climate. The Texas Red variety yields fairly well but does not seem to be as profitable as barley.

Wheat of several varieties has been grown in the valley and has given good results in most cases. Wheat is not so well adapted to this locality as barley, as shown by the fact that it has been almost entirely supplanted by barley during the past nine years. The rust which attacked the wheat in 1905 was no more serious than in other parts of the State that same year, consequently the statement that wheat is more susceptible to rust in Imperial Valley than in other localities is not true. The general cultural treatment for wheat is the same as that for barley.

GRAPE GROWING IN THE IMPERIAL VALLEY.[7]

From the beginning of the settlement of the Imperial Valley, about ten years ago, the growing of grapes has received a great deal of attention. There are at present about two hundred growers of grapes, possessing vineyards of various sizes, from one hundred vines up to one hundred acres or more, scattered over the Valley from Brawley to Calexico. These vines are all of *vinifera* varieties, only an occasional vine of a *labrusca* or other East American variety being found. The total area in vines is probably about 500 to 600 acres, although the County Recorder places the number of vines in the county in 1909 at only 159,565.

The rapidity of growth and vigor of the vines is remarkable and

[7] By Frederic T. Bioletti, Viticulturist, California Experiment Station.

their fruitfulness and earliness of bearing scarcely less so. The fruit ripens from two to six weeks earlier than in any other part of California except in the Coachella Valley, which is part of the same climatological area.

Fig. 26.—Three-year-old Sultanina vine on Reid ranch.

With these favorable conditions there seems to be every reason to anticipate that the growing of grapes will be a very profitable industry in the valley. On this point, however, there is a great diversity of opinion among the growers. While some growers seem to have done very well, others have failed to make a profit out of their crops. One of the reasons given for failure to realize a profit is the high cost of transportation and labor. But the price of such grapes as are accepted

by the packers is also high, being $50 to $60 per ton at the packing house in 1910. Another reason given is that the grapes grown in the Imperial Valley have poor shipping and keeping qualities and that only a small proportion get to the market in good condition. As a matter of fact, some of the grapes grown in the valley have exceptionally good keeping and shipping qualities. The true main reason for the failure to make grape growing pay seems to lie in the failure to adopt suitable methods of growing and treating the vines and grapes. The climatic and soil conditions are peculiar and different from those of any other grape growing section of California, and special methods are necessary to insure profitable returns. The full profit of the industry will be realized only when the methods best adapted to the conditions are generally known and followed. What these best methods are, study, time and experience alone can determine.

Every phase of the subject, from the preparation of the ground for planting to the delivery of the grapes to the consumer, requires investigation. Already, indeed, a considerable amount of experimentation, intentional and otherwise, has been carried out. Grape growers from widely differing viticultural sections have been planting and cultivating vines in the valley for several years, all modifying their practice more or less in accordance with the customs of their old homes. A large number of *vinifera* varieties have been introduced and tested. On many points, therefore, there is experimental data on which to make comparisons and form conclusions.

At present, the grapes are grown exclusively for early shipment as table grapes or for local consumption. The principal shipping season extends from about the middle of June to the end of July, varying somewhat in different years. The great bulk of the grapes consists of Sultanina (Thompson's Seedless), Malaga, and Muscat of Alexandria, ripening in the order named. The shipments of Malaga far exceed those of all other varieties combined. The season could undoubtedly be lengthened by the use of varieties ripening before the Sultanina and of very late varieties. The latter would come in competition with varieties from other sections, but being very distinct in character they would undoubtedly find a market.

Preparation of the Soil.—It is very important that the vines should have strong root systems penetrating deeply into the soil.

In many, probably in most, of the vineyards of the valley the vines have shallow spreading roots confined to the top foot of soil. In several cases examined, no roots as large as a pencil were found below ten inches from the surface. Such vines may grow vigorously and

even bear heavy crops so long as the layer of soil in which the roots lie is kept moist. This requires numerous irrigations throughout the growing season. The omission of one irrigation may seriously damage or kill vines in this state of unstable equilibrium. Even when the irrigations are not neglected the conditions are not favorable for the best results. Where the roots are confined to the upper twelve inches

Fig. 27.—Vine with shallow horizontal root system, very objectionable.

of soil they are subject to constant changes in moisture and temperature. This condition is unfavorable to the proper development and nourishment of the fruit and does not tend towards the production of grapes of the highest eating or shipping qualities.

With a deep root system penetrating six, eight, or more feet in depth, the growth of the vine is more regular, the grapes ripen more regularly, are firmer and of better flavor. Moreover, fewer irrigations are needed and the omission of one will not have such serious consequences.

The position of the main roots of the vine is fixed by the growth of the first year. Where this growth will be is determined by the *soil conditions* and *not* by the *length* or *position* of the *cutting*. The roots

will grow where they find the most favorable temperature and moisture. If the soil at two feet is dry the roots will not grow there, however long the cutting may have been. If the soil at six feet has the proper degree of moisture the roots will go to that depth, however short the cuttings. Before planting the vineyard, therefore, the soil must be thoroughly soaked down to five or six feet at least.

Owing to the filling up of the soil pores with the silt carried by the irrigating water, this deep wetting cannot be accomplished on hard soils by ordinary furrow irrigation or a single flooding in the usual manner. Some more efficient method of wetting such soils must be found if the vines are to be placed on a stable basis.

Probably the growing of alfalfa on the land for two or three years before planting would be the best means. The repeated heavy floodings would finally moisten the soil down to the required depth and the alfalfa would improve the humus and nitrogen contents of the soil. Another method adopted with success by some growers is to check up the land with levees high enough to allow of flooding each check to a depth of one or two feet. When the water of this first flooding has disappeared by soaking in and evaporation the check is flooded again. Two or three floodings of this kind will, in most cases, wet the soil down sufficiently deep. Another method suggested is a prolonged slow irrigation with very small furrows. This, however, is laborious and less certain to moisten all the soil equally.

Choice of Cuttings and Roots.—If the soil is properly prepared by soaking and deep plowing, cuttings should succeed almost as well as roots.

The cuttings should be chosen, made and handled properly.[8] With care in planting and cultivation, ninety per cent. or more of them should make a good growth. Those which miss should be carefully replaced the following year with rooted vines.

The length of the cutting is not of great importance providing it is long enough not to run any risk of becoming dry before it roots. From fourteen to sixteen inches is a convenient length. Longer cuttings simply increase the cost of planting without any corresponding benefit.

The soil, after irrigating, should be plowed, harrowed, and gotten into perfect condition before planting. The cuttings, after soaking in water for one to three days, should be planted with care to avoid drying. The soil should be packed tightly around the cutting from

[8] See Circular 26, "The Selection and Preparation of Vine Cuttings," Agricultural Experiment Station, Berkeley, California.

the bottom nearly to the top and only one bud left above the surface.

If the soil is sufficiently moist when the cuttings are planted, no irrigation will be necesary for several weeks. Repeated cultivation to keep the surface loose and so preserve the moisture already in the soil

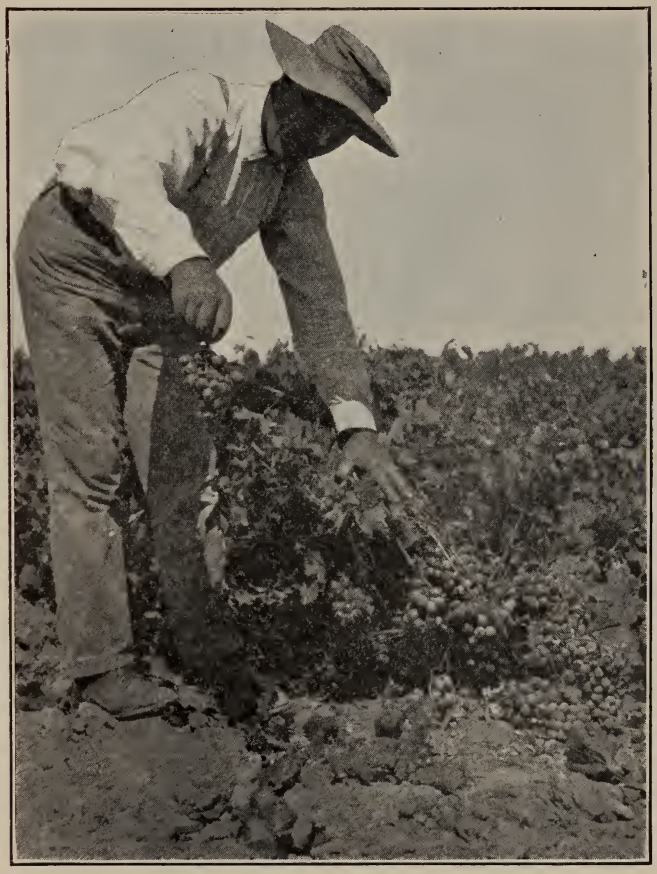

Fig. 28.—A vine pruned too low, grapes massed together and lying on the ground.

is better than any irrigation at this time. By keeping the top four to six inches of soil loose and dry the moisture below that depth is prevented from escaping and the roots are encouraged to take a downward direction. If, however, the soil has become a little too dry on top before planting, a small stream of water should be run down each

row, giving the soil around each cutting a good soaking. Care should be taken to avoid flooding the whole vineyard, as this will tend to form a crust and make it difficult to preserve the moisture-holding soil mulch.

During the summer, the young vines should be kept growing by cultivation and, when necessary, irrigation. Frequent shallow irrigation should be avoided. Some means of getting the water down below the top eight or ten inches should be found. *Shallow irrigation the first year produces shallow rooted vines and shallow rooted vines in the hot dry climate of Imperial have a precarious existence.*

Form of the Vine.—Just as the general character of the root system is determined by the growth of the first year, so the form of the mature vine is determined by the growth and training of the first one, two, or three years. In fact, in Imperial County the growth is often so large the first year that the treatment the vine receives during this year determines whether we have a vine which can be handled with economy and profit or one which costs far more than it ought to prune and cultivate, and which produces only second rate grapes of poor shipping qualities. A considerable amount of extra care and expense the first two years will undoubtedly be more than justified and returned by saving of expense and increased returns from the bearing vineyard.

A poorly shaped vine, lying on the ground, with crossing and interlocking arms is difficult, in fact impossible, to prune and cultivate properly. The grapes on such a vine lie on the ground, become soiled, moldy and ripen unequally. When they are gathered, the best bunches cannot be taken from the vines without breaking and bruising a large proportion of the berries. The result is that only about fifty per cent. of the grapes will be accepted by the packers, and this fifty per cent. is often handled at a loss owing to poor keeping qualities.

What the best form for the vine is, under the conditions of Imperial County, it is impossible to say with our present experience. But there is room for much improvement in the present practice of a majority of the vineyards and there are certain characteristics that may be accepted as necessary for a good vine.

In the first place the vine should have a clear, straight trunk without arms, spurs or branches, at least fifteen inches high. At the top of this trunk the arms bearing the fruiting wood should be so arranged that the bunches of grapes hang free from each other and from growing shoots. As much as possible each bunch should be

exposed equally to light and air and should be so placed that it is possible to gather it by the stem without breaking or even touching a berry.

Fig. 29.—Mature vine of proper shape.

This may seem an impracticable refinement. It should be remembered, however, that bunches of perfect grapes of good shipping qualities can be sold for $50 per ton, while poor grapes are worth only about $5 for hog feed. The gross returns, therefore, from five acres of good shipping grapes are equal to those of fifty acres of poor grapes and the net profits may be ten times as great. Many growers could undoubtedly very much increase their profits by concentrating their labor and expense on half the area they now cultivate.

For most of the varieties now grown in Imperial County the open vase form of vine is an excellent one. In this form, six to eight arms, arranged symmetrically around the head or top of the 15 to 18 inch trunk, spread out in all directions, rising at an angle of about 45° to 30° from the vertical. This form makes it possible to cultivate close up to the vine without injuring it and arranges the bearing wood in such a way that the bunches are well spaced without interference and easy to get at.

This or any other suitable form cannot be attained without the use of stakes. Where the vines make a large growth the first year, the stakes should be placed when the vines are planted. The way of handling the young vines to get them into the desired shape is described in Bulletin 193, pp. 146 to 155.[9]

Fig. 30.—Young vine staked and properly started.

Irrigation.—Among the most difficult problems are those connected with the proper irrigation of the vineyards.

The desirability of deep and not too frequent irrigation of young vines has already been pointed out. It is equally necessary for bearing vines. Some growers of small vineyards keep their vines irrigated almost constantly. Other vineyards are left five months without irrigation. The proper number will depend in any particular case principally on the position of the roots. With deep rooted vines three or four thorough irrigations during the year seem to be all that are necessary, providing the cultivation is well done.

The best time for these irrigations is perhaps not yet determined. In this respect two important points should be kept in mind.

First: Any rapid and considerable addition to the moisture of the soil during the last stages of ripening injures the shipping qualities of the grapes. The grapes become watery, surcharged with sap and

[9] Bulletin 193, Agricultural Experiment Station, Berkeley, California.

are easily broken or detached from the pedicle by a touch. The last irrigation before gathering the crop, therefore, should not be later than the commencement of ripening. If the irrigation and cultivation has been properly done up to that point the soil should contain enough moisture to bring the grapes to the shipping point of ripeness.

Second: A vine, for the best results, should have a dormant or resting period. In the tropics, where the atmosphere is constantly warm and the soil constantly moist, the vine becomes an evergreen. The grapes produced under these conditions are of poor quality, deficient in sugar and flavoring. The growth of the vine is not checked completely by cold until the mean daily temperature falls below 48° F. The mean daily temperature for December, the coldest month at El Centro in 1909, was 50.25° F. If this alone controlled the dormancy the vine should remain evergreen. There are, however, one or two days each year, usually in December or January, when the temperature drops to the freezing points or a few degrees below. This is sufficient to make the vine lose its leaves and remain dormant for a short time before the new buds swell.

For the best results the vine seems to need about three months rest. In order to insure this, the vine should commence its dormant season before the December or January frost. This can be controlled by suitable management of the irrigation.

When the moisture content of the soil falls below a certain percentage the vine ceases to grow. When the soil becomes still dryer the leaves turn yellow and fall and the vine becomes dormant. The irrigation should be so applied, therefore, that the vines are caused to become dormant by drying of the soil, sometime in November. The drying of the soil should not be too early or too intense or the vines may be injured.

After the grapes are gathered a very important part of the work of the leaves still remains to be accomplished. This work is the ripening of the young canes and the laying up of stores of starch in the buds and other organs of the vine. It is on the abundance of these stores that the growth and crop of the following year depend.

This laying up of winter stores by the action of the leaves requires a month or six weeks and takes place most abundantly when the vine is provided with a large number of mature green leaves but is making little or no new growth. In some cases an irrigation immediately after the gathering of the grapes would be necessary or advisable to prevent the premature dropping of the leaves.

Intercalary Crops.—Many growers have been raising melons and other annual crops between the vines, especially during the first year or two. It is doubtful whether this is good practice so far as the success of the vines is concerned. Any crop which requires frequent irrigations leads to the keeping of the top layer of soil unduly wet and promotes the shallow rooting of the vines. It is possible that by growing the intercalary crop in the middle of the row and irrigating

Fig. 31.—Cantaloupes, apricots, and grapes growing together.

in such a way that the top soil near the vines is not moistened by each application of water that no harm would be done to the vines when young. Any crop which requires constant or frequent irrigation should not be grown among bearing vines or the quality of the fruit will suffer.

Other growers make mixed plantings of fruit trees, peaches, apricots, etc., with vines. There are indications that this may be a good practice. The trees break the force of the wind and make it easier to raise the vines and give them a suitable shape.

Diseases of the Vine.—So far no fungous disease of the vine of any importance has been noted in Imperial County. The dryness of the air during the growing and ripening season of the early grapes makes it unlikely that there should ever be much trouble from this source. The moister weather which occasionally occurs after mid-summer might involve danger in this respect, but no fungous disease has yet been called to the attention of the Experiment Station.

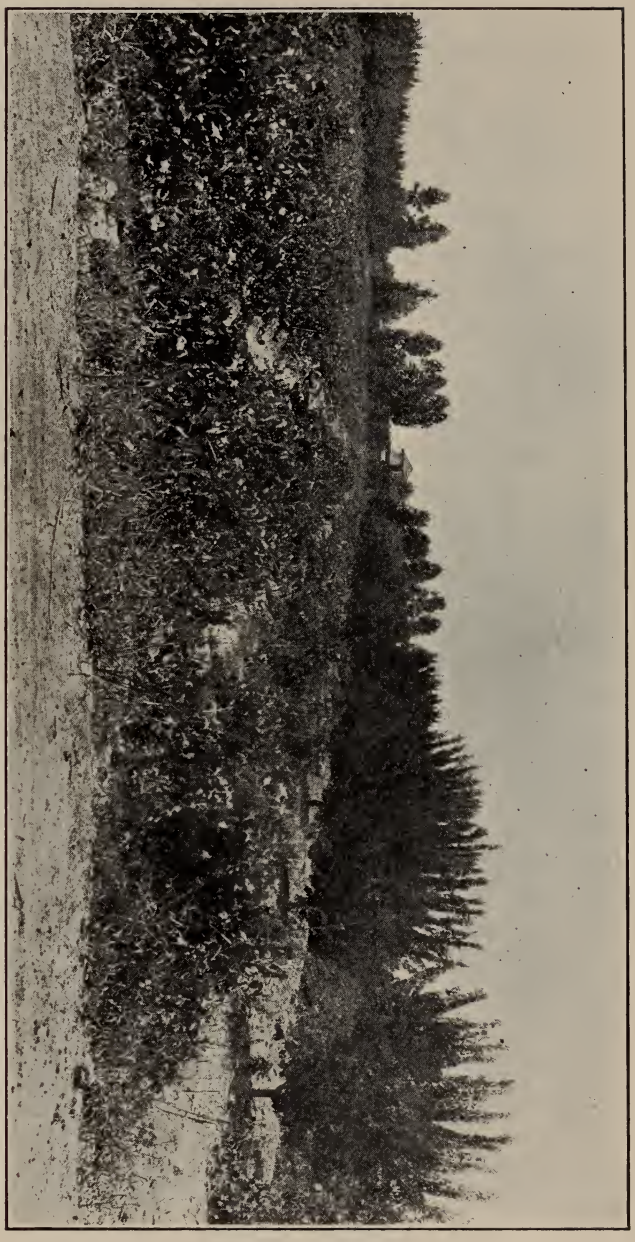

Fig. 32.—Vineyard with rows of apricots as windbreak.

The only serious insect pests that have been noted are the vine hopper and a species of thrips.

The vine hopper seems at present confined almost entirely to one locality, but it is possible that it may become as serious a pest as it is in many other parts of California. The only method of control which so far offers much chance of success can be applied effectively only to vines which have a distinct trunk with all arms well off the ground.[10] This offers another forcible reason for adopting the mode of training recommended.

The thrips have been found in large numbers on the vine blossoms. So far as noted, no particular damage seems to have been done, as their attacks were confined to the second crop.

Several cases of dying vines were investigated. In some cases the numbers of dying and dead vines was large. In all cases the trouble seems to be due to mistakes in irrigation or cultivation. In the worst cases the trouble seemed to be due to the shallow rooting of the vines and their consequent sensitiveness to heat and drouth.

This valley, like all of southern California, seems to be so far free from phylloxera. It is advisable, therefore, that the present strict quarantine should be maintained against all rooted vines from outside the county and especially from eastern states and Europe. The exclusion of *unrooted* cuttings, however, works an unnecessary hardship on those growers who wish to plant or experiment with varieties which cannot be obtained in the county. There is very little danger from cuttings grown in California and this danger can be eliminated by disinfection under the direction of the horticultural quarantine officer.

Handling the Grapes.—The profitable production of grapes in Imperial County at present and probably in the future can be carried on only by the methods of intensive culture. Wholesale, careless methods may in some regions yield a profit in growing wine grapes or raisin grapes, but the conditions for these industries are not at present favorable in this region. Fine early table grapes that can be placed on the eastern market in prime condition will command high prices. Inferior grapes or grapes which spoil before they reach the consumer are hard to give away and can never yield a permanent profit.

Every reasonable effort, therefore, should be made to produce only the choicest fruit. An extra expenditure of $25 to $50 per acre is justified if the salable value of the crop is increased $100 or $150 per acre.

[10] See Bulletin 198 and Bulletin 193, pp. 111-116, Agricultural Experiment Station, Berkeley, California.

The preceding suggestions regarding improvements in planting, pruning, training and irrigation have this in vew. The proper handlng of the grapes is no less important. A bunch of grapes which is perfect in the vineyard may be easily ruined by careless gathering or hauling before it reaches the packing shed.

The grapes, in *gathering,* should be touched as little as possible and handled only by the peduncle or main stem. They should be placed carefully in wide shallow boxes in a single layer. In these boxes they should remain for twelve to twenty-four hours to wilt slightly and lose their rigidity before packing and, if possible, before hauling. If they are warm when picked they will wilt more rapidly and proper packing without injury to the berries will be facilitated. Hauling to the packing house should be done very carefully, preferably in wagons provided with springs. The grapes should be protected from the dust and the direct rays of the sun, and the boxes should be so stacked that there is no danger of crushing the grapes.

Removal of Suckers.—Many bunches are injured in gathering, owing to the necessity of freeing them from suckers and water-sprouts which have grown through the middle of the bunch. Some of the grapes are pulled off, some broken and, worst of all, some of them are slightly loosened around the pedicel or stalklet. Most of the broken berries can be removed by the trimmers in the packing house, but many of those simply loosened will escape their scrutiny and are a fruitful cause of decay.

By going over the vineyard soon after the grapes have set, interfering shoots can be removed or freed from the bunches. The cost of this should be abundantly returned by saving in labor of gathering and trimming and especially in improvement in the shipping qualities of the whole crop. In long shipments one spoiled bunch may infect a whole crate.

Thinning.—Many otherwise suitable grapes do not ship well on account of the excessive compactness of the bunch. A compact bunch is difficult to pack without injury and cannot be freed from imperfect berries without spoiling good berries.

This excessive compactness can be prevented by thinning before the berries are one-third grown. Thinning, moreover, increases the size of the berries, hastens ripening, promotes coloring, and lessens some forms of sunburn. The practice is regularly followed with success by many growers of Tokay, Black Morocco, and other grapes in northern California. While apparently costly, the expense is often more than counterbalanced by the saving in trimming of the ripe grapes. The increase of quality thus becomes a net gain.

The bunches are thinned at any time after the berries have set and before they have reached one-third their mature size.

No bunches are removed, but only a certain proportion of the berries of each bunch. The number of berries to be removed will depend upon how compact the unthinned bunches usually become.

Fig. 33.—Bunch of green grapes before thinning.

In general, it will vary from one third to one half of the total number. The thinning is effected by cutting out several of the side branchlets of the bunch. The branchlets should be removed principally from the part of the bunch which has most tendency to compactness, usually the upper part. The work can be done very rapidly as no great care is necessary in preserving the shape of the bunch. However irregular

or one-sided the bunch looks immediately after thinning, it will round out and become regular before ripening.

Fig. 34.—Bunch of green grapes after thinning.

A long, narrow bladed knife or a pair of grape trimming scissors can be used conveniently for this work.

Varieties.—A very large number of varieties have been planted in Imperial Valley. On a recent trip about sixty varieties were seen in

bearing. Many of these were too young or too few for a judgment to be formed as to their value. The principal object of the growers who were testing these varieties seemed to be to find a variety of good shipping qualities earlier than the Malaga and especially to find a suitable black or red grape. There seemed to be a general impression that grapes ripening much after July first were poor in quality and did not ship well.

Early Grapes.—Several varieties were seen ripening one to two weeks before the Malaga and Sultanina (Thompson's Seedless).

The *Luglienga* has been planted by several growers but is generally disappointing. It ripens very early, but the bunches are small and compact and the berries juicy and soft. It is inferior in these respects to the same variety grown in the Coachella Valley. It is probable that it could be much improved by longer pruning and thinning of the bunch.

The *Chasselas doré* and *Chasselas rose* (White and Red Sweetwater) have the same defects as the *Luglienga* and seem subject to sunburn.

The earliest black grape seen was the *Blue Portuguese,* but it has little to recommend it except earliness. The berries are small and too juicy for distant shipping. The *Bellino* is a black grape almost as early as the Blue Portuguese and very superior in appearance and shipping qualities. This is the most promising of the early black grapes.

A few of the Persian varieties were found bearing in several vineyards and some of them promise to be superior to any of the early grapes yet tested. They have nearly all a family resemblance in delicacy of texture and flavor, combined with a certain absence of juiciness which promises well for their shipping qualities. They vary considerably in color, shape, and time of ripening.

The varieties known as *Persians Nos. 21, 23, 24,* and *26,* resemble each other very closely. They are all yellowish white, short, cylindrical and very early, ripening one or two weeks before the Sultanina and at least as early as the Luglienga and Chasselas. They are larger and of finer appearance than these varieties. The bunches are well filled but loose and easy to pack. The *Dizmar* and *Khalille,* also Persian varieties, belong to the same group. The *Chavooshee* is a long white grape ripening about the same time. The *Hutab, Alakahee,* and *Rish Baba* are large, elongated, curved white grapes ripening a little earlier than the Malaga and are all very striking in appearance and promise to be of good shipping quality.

The red Persian grapes, the *Paykanee* and the *Ashakanee,* should be well tested. They are very early, of excellent quality, and very ornamental. The former seems to be the best and is the only one fruiting in the Imperial Valley. It is of a bright red tint, large, elongated and pointed. While very soft and delicate to eat it is not juicy, has large loose bunches and would probably ship as well as the Sultanina.

The *Askaree,* the only black Persian grape we have, has not yet been tested in the Imperial Valley. It has most of the good qualities of the other Persians but is a little more delicate and might be difficult to ship.

The varieties grown under the names Persian 20, 22, and 25 are small, juicy, and unsuited for shipping.

The *Dattier de Beirut* is a large oval grape, ripening before the Malaga and should be tried.

Of varieties ripening about the same time as the Malaga the most promising is the *Olivette de Cadenet.* Several vines of this variety were seen in fruit and in all cases they were doing well. The grapes resemble very closely those of the Malaga but seem to be of a little better quality both for eating and shipping.

The *Golden Queen* and the *Kurtelaska* are also promising varieties. They are white, large, nearly round, firm, and heavy bearers.

The *Bermestia violacea* is a large, oval, reddish grape ripening about the same time and may be a valuable variety.

The *Black Damascus* is the only black grape planted in large quantities and it is generally successful. It is a heavy bearer, producing large bunches of fine oval grapes that ship well.

A *Black Muscat* and the *Moscatello fino* are also promising. They bear well, the grapes are highly flavored and large, and they ripen sufficiently early. They would probably be too delicate for distant shipment.

GRASSES.

Australian Rye Grass (*Lolium multiflorum*), being an annual does well during the winter months, but dies out during the summer. It is an excellent grass for a winter lawn, being frequently planted in Bermuda lawns in the fall. During the winter it appears very much like common blue grass.

Bermuda grass (*Cynodon dactylon*) is a pest on ranch lands in the valley, but is grown for a lawn on many of the town lots. It makes

a very vigorous growth during the summer, but lies dormant during the winter. On the farms the Bermuda grass spreads very rapidly by both seeds and jointed runners, and is very hard to eradicate when once established. By constant cultivation the grass can be kept out, as is done in the orange districts of southern California. It can be eradicated by plowing the land and then letting it go dry all summer. The roots should be kept stirred by cultivation so that they may dry completely. When the moisture content in the soil remains high, however, the roots are apt to live over. On some of the hard Imperial clay lands Bermuda is grown for pasture. It makes fair feed when alfalfa cannot be successfully grown.

Blue grass (*Poa pratensis*) grows well during the winter season but does not endure the hot weather well. If care is taken to keep the ground well soaked it will live through the summer but never does well.

Johnson grass (*Sorgum halipense*) has proved such a serious pest especially when it becomes established in the ditches and along borders that a strenuous effort is being made by the Horticultural Commissioner to exterminate the Johnson grass which is at present in the valley. It has been introduced through seed, but is at present confined to about sixty ranches. Two men are hired especially to dig these patches out and to prevent any new growth. By a rigorous inspection of seed, additional importations may be prevented.

Millet (*Choetochloa Italica*).—Most varieties of millet do fairly well in this section. Very little millet is planted, however, since other forage crops produce better results. It is generally sown during the latter part of the summer and harvested in the fall. Frost kills it about as readily as Indian corn. Pearl millet (*Pennisetum spicatum*) can be grown successfully in the spring and will make a good growth during the spring and summer.

Orchard grass (*Dactylis glomerata*) can be made to grow in Imperial Valley, but it is not suited to the climate and its culture is no longer attempted.

Para grass (*Panicum molle*) was introduced into the Valley in 1909 and has made a remarkable growth in the few patches where it was planted. It is considered a bad weed in moist tropical countries, although it is used as a pasture grass and for hay. It propagates from the nodes of the stem and consequently is hard to eradicate when once started on wet land; but in an irrigated section it can be dried out by withholding water and cultivating it down. It may prove to be a valuable plant for the hardest soils of the valley where alfalfa

will not do well. It is a rapid grower and can be cut every six weeks or so during the summer time. While it is sensitive to cold, it will withstand any low temperature likely to occur in Imperial Valley.

GUAVAS.

The common guava (*Psidium Guajava pyriferum*) is too tender to frost to succeed in the Imperial Valley unless it be in some exceptional nooks or corners of the valley which may be found to be frostless. The strawberry guava (*P. cattleianum*) is somewhat more hardy to frost and might be expected to grow in slightly protected situations. The writer has not yet found old bearing plants in Imperial and the question as to how the climate will affect the fruiting of this plant has yet to be settled. *Psidium araca* is reported as frozen to the ground at Brawley during the winter of 1909-10.

HEMP.

The hemp plant (*Cannabis sativa*), has been found to grow thriftily in the valley, especially after being somewhat acclimatized. The yield has not been carefully determined. The question of whether hemp culture would be profitable on a commercial scale will depend largely on the economic conditions.

JUJUBE (*Ziziphus Jujube*).

Judging from a single specimen, the jujube, sometimes called the Chinese date plum, succeeds quite well. It bears two crops of fine fruit. The writer observed a plant near Brawley ten feet high and full of fruit. It seemed to be making a healthy and vigorous growth. While this is not a commercial fruit, it is an interesting tree to grow on the home grounds as a curiosity or as an ornamental.

KAFIR AND EGYPTIAN CORNS. (*See under Sorghum.*)

KUMQUATS.

This species of citrus fruit is not grown in California to any great extent as a commercial product. Kumquats are very desirable for eating fresh or for making preserves. They will grow and produce several crops of fruit a year in the Imperial Valley, although they are likely to be killed back to some extent some winters by the frost unless protected. The variety *Marumi* is said to be more hardy to cold than the *Nagami*. Kumquats deserve to be much more generally planted in home gardens.

LEMONS.

There seems to be no good reason why lemons should not be grown in the Imperial Valley in sufficient quantity to supply the population in the valley. Whether or not their culture will prove profitable on a commercial scale it is difficult to say. It is a fairly well established fact that the lemon thrives better and bears a much larger amount

Fig. 35.—Four-year-old lemon tree, Bixby ranch.

of high priced early summer fruit when grown near the sea or within the influence of the cool, moist sea breezes. We would therefore expect that the hot, dry climate of the Imperial Valley would place this region somewhat at a disadvantage with the coast country. The prevailing winds would also tend to cause a large proportion of the fruit to be scarred unless effective windbreaks were used. The records of the Weather Bureau have not been kept in the Imperial Valley for a sufficient number of years to furnish a reliable indication as to how often severe frosts may be expected.

All things considered, it does not seem wise for settlers with a

limited amount of capital to embark in commercial lemon culture. It would be better to wait a few years for the State Experiment Station to gather data on experimental plantings and report on the likelihood of the industry being made profitable. It is highly desirable, however, for everyone to plant one or two lemon trees on their home grounds from which to gather fruit for home use. At present no citrus scales are known to exist in Imperial Valley and consequently no expensive fumigation will be necessary. The most popular varieties in California are the Eureka and Lisbon.

LETTUCE.

Lettuce produces very satisfactorily when grown during the cooler part of the year. Seed may be sown in succession from the latter part of September to the end of February. All varieties so far grown have given satisfaction and seem about equally adapted to the region.

LICORICE.

The licorice plant is a low growing perennial which spreads rapidly by underground stolons. It thrives wonderfully in Imperial Valley and should be regarded as a pest and not allowed to gain a foothold. The high price of labor prohibits the profitable digging of the roots for sale.

LIME.

Limes are citrus fruits which are probably too tender to frost for the Imperial Valley, except perhaps in the most sheltered situations. It would be possible to grow a tree for home use provided protection were given during frosty nights with a tent or otherwise.

LOQUAT.

Loquat trees may be expected to grow well and make quite ornamental small evergreen trees. The trees will endure much more cold than is likely to occur in Imperial. They bloom, however, in midwinter and the flowers being tender to frost are usually killed, resulting in the tree being unfruitful. Trees budded on quince stock are more resistant to alkali than when grown on their own roots.

MULBERRIES.

All varieties of mulberries may be expected to grow well and produce abundant fruit. They are valuable for avenue shade trees but are objected to by many on account of the litter made by the dropping fruits. They are especially useful both for shade and fruit

in poultry yards. The Russian mulberries ripen very early, while Black Spanish (*Morus nigra*), ripens later. The Black Spanish mulberries leaf out late in spring but they make an extremely dense shade during the summer. The fruit of this kind is larger than that of any other mulberry and is quite palatable, containing more acid than the insipid Russian kinds. The varieties recommended are Black Spanish, New American, Downey, Black Russian and Victoria.

MUSKMELON.

The muskmelon, or cantaloupe as it is usually called in Imperial Valley, is eminently adapted to the region and produces abundant crops of high quality, early fruit which carries well for long distances. Imperial Valley cantaloupes have been shipped extensively to all parts of the east, even as far as Boston, Mass. Owing largely to the quick money returns the cantaloupe early became a popular crop, so popular in fact that the business was overdone in 1908, when more than 3,000 carloads were sent out of the valley. Owing to various unfortunate circumstances and the low price received for the product, much money was lost by the growers that year. More conservative plantings and better methods of packing have made possible the marketing of subsequent crops at a fair profit. Melons from Imperial Valley are esteemed for their earliness, and shipping ceases as soon as the crops from other regions reach the market.

The soft, sandy soils, free from alkali, are of course best suited for this crop; old alfalfa ground being better than other land. The ground is plowed, harrowed and irrigated in borders. It is later reworked and low ridges are thrown up six to eight feet apart and again soaked with water. The seed is planted from February 10th to the first of March. After the plants begin to run they are watered every ten days or two weeks, each irrigation being followed by a thorough surface cultivation until the growth of vines interferes.

The harvest usually begins about the middle of May and continues from six to eight weeks, the yield varying from one hundred to as high as three hundred or more crates per acre.

The melon aphis is the most serious pest and often does much damage. It often appears late in the season, however, injuring the later and less valuable melons more than the early ones. No very satisfactory remedy has as yet been devised. It is important to defer the general spread of the aphis as late as possible by destroying the first scattering colonies as they appear. This is best done by burning the vines with the use of gasoline or shoveling soil on the infested vines

Fig. 36.—Irrigating melon ground before planting.

Fig. 37.—Melon field just after planting.

and burying them where they are. It is unwise to attempt to pull and carry out of the field the infected vines, as this is very apt to spread the insects. Effective spraying is very difficult on account of the impossibility of reaching the aphids on the under sides of the curled leaves. There is a native parasite, a Berconid fly, which destroys large numbers, and the large numbers of predacious lady bugs liberated in the valley have been observed to feed upon them.

Fig. 38.—Cantaloupe packing shed, Brawley.

OATS. (*See under Grain.*)

OLIVES.

It is the writer's opinion that the olive stands second only to the date in its adaptability to the conditions of the Imperial Valley. From whatever angle we view the question the olive appears to have a distinct advantage. It will be strange indeed if in the future years Imperial County does not lead all California counties in the production of olives.

In the first place, the home of the olive is in those parts of northern Africa and southwestern Asia where the climatic conditions most nearly approach those of Imperial Valley. The olive tree, therefore,

is perfectly at home in the valley and making a rapid and healthy growth, comes into bearing early and produces heavy crops of very high quality fruit. Along the California Coast the olive tree is much

Fig. 39.—Mission olive tree three years old.

hampered by the ravages of the black scale, but there is no black scale in the Imperial Valley at present and for various reasons it is not likely that this scale will ever gain a foothold. Olive trees are therefore clean and healthy and of course require no expensive spraying or fumigation.

The olive has another advantage in that the crop is harvested and manufactured into pickles and oil during the delightful fall and winter months, when labor is easier to secure than at any other time of year. Then also the cotton industry will attract large numbers of cotton pickers into the valley in the late summer and early fall who will be available for olive picking during the winter.

In every arid country dependent upon irrigation from canals the water supply is occasionally subject to possible interruptions. In the case of citrus or deciduous orchards this may result in the death of the trees and thus the work of many years may be lost. In the case of olives, however, the fruit falls but the trees remain alive even for several years awaiting the return of irrigation water, when they will again produce profitable crops.

Olive trees are very long lived. There are old orchards in Italy which continue to produce profitable crops at an age of several hundred years. The outlook for the increased demand for olive products is becoming brighter as the country gradually recovers from the effects of the wholesale deception and fraud used before the pure food laws went into effect. If the markets of the eastern United States could be educated up to ripe pickles, the consuming public would use pickled olives as a food rather than as a condiment and the consumption would be increased enormously.

All varieties of olives will grow well in Imperial Valley, but some varieties have been found more profitable than others. Some varieties are best for oil and others for pickles, but it has been found good business policy to operate a pickling plant in conjunction with each oil mill, in order that there may be no waste. The best general purpose variety is the *Mission,* originated at the San Diego Mission, California, which is away ahead of any other variety ever tested in the arid southwest. Other varieties highly satisfactory for oil making are *Correggiola, Pendulina, Razza,* and *Nevadillo.* The *Manzanillo* ripens early and is a good pickling olive, but it cannot be used for oil unless it is mixed with a large percentage of the oil of other varieties. This is due to the fact that Manzanillo oil becomes turbid at 75° F., and semi-solid at 50-60° F., thus giving to certain persons the impression that it is impure.

Every farm home in the Imperial Valley should have two or three Mission olive trees from which to make sufficient ripe pickles for home consumption.

ONIONS.

Onions are very successfully grown in the Imperial Valley as a winter crop. Seed is planted in seed beds in August and September and the small plants with tops and roots trimmed are transplanted in November and harvested in March and April. Soft soil which has been in alfalfa for some time is much the most desirable. The

Fig. 40.—Field of winter onions.

crop is grown on flat ridges from three to four feet wide from center to center with two rows on the ridge. Water is applied plentifully during the growing season, but is gradually withheld as the harvest approaches, in order to secure a firmer better shipping onion. Cultivation should be frequent and thorough. The crop is packed in crates holding 50 pounds each and should be shipped to market as soon as possible after harvest.

It has been found that more skill is required to market the crop successfully than to produce it. The crop is easy to grow, from three to four hundred crates per acre being a common yield. The market, however, has been so unstable and variable that some years the growers realize good profits and in other years they lose money after producing good crops of onions. It is hoped that some system of marketing may be devised which will place onion culture on a more satisfactory and stable basis.

White Bermuda is the variety most generally planted, while Crystal White Wax does well, but is not quite such a good shipper.

The most serious pest yet encountered is a species of thrips found on the young plants, although some years there is little damage done. Spraying with kerosene emulsion or a soap or tobacco solution is the only remedy known for this pest.

Fig. 41.—Harvesting onions grown between grape vines.

ORANGE.

The question as to whether Imperial County will take its place among the important orange producing counties of California is a much discussed and very important one. There is no doubt about the desirability of planting sufficient orange trees about the home grounds to produce fruit for domestic use. The question arises as to whether the amount of risk involved in planting large commercial orchards and bringing them into bearing is balanced by the likelihood of profit.

Experience in Imperial Valley as well as in the Coachella and Salt River Valleys has shown that the Navel orange growing in the dry air and bright sunshine of these localities has a distinct advantage in that it sweetens earlier and has a deeper red color than when grown in other parts of California. Early, sweet, high colored fruit is in active demand at very good prices. This marked advantage is not

held by the Valencia Late orange and it is doubtful whether the culture of this variety would be sufficiently profitable to warrant its extensive planting. Another advantage held by the Navel orange is that being picked and shipped early, the fruit would not have to run the risk of being frosted during the winter.

There is considerable evidence which goes to show that orange trees make a very satisfactory growth and produce well under the climatic conditions of Imperial Valley wherever they are given intelligent care. It is, of course, important to plant them on land which takes

Fig. 42.—Second summer's growth of orange trees near Imperial.

water readily to a considerable depth, for the orange is quite dependent upon an abundant and regular water supply. The tree trunks should be given artificial protection from the sun in summer and the frost in winter for the first year or two, and headed low so that the foliage may continue this protection as the trees grow larger. The humus content of the soil should be increased by plowing under cover crops, spoiled alfalfa hay, manure or other organic refuse. A high humus content seems especially desirable for orange trees.

One of the most important points to be considered in connection with orange culture is the liability of each locality to destructive frosts. In regards to this, we cannot give any conclusive data for the reason that the country is so new that Government Weather Records have not been taken for a sufficient number of years to give an accurate idea of the risk. There is no doubt that the degree of frostiness varies considerably in different parts of the valley. It has been

reported that in certain localities along the New and Alamo Rivers that tomato vines have grown continuously for several years, thus proving the absence of frost. On the other hand, there has been a report from low grounds in the vicinity of Cameron Lake near the International line of a temperature of 13° F. occurring on January 2d, 1901. From this it will be seen that the comparative frostiness of each locality should be investigated before large sums are invested

Fig. 43.—Old orange orchard near Yuma, showing weeds used as a mid-summer cover crop.

in citrus culture. For purposes of comparison the annual minimum temperatures taken by the Government observers at Imperial, Heber, and Calexico are given in the following table: The figures for Riverside are included for the sake of comparison.

	Lowest Temperature F. Reached at				
	Riverside	Imperial	Calexico	Heber	Brawley
1903	24	26	.....	.....	.....
1904	27	28	.....	.....	.....
1905	26	22	29	.....	.....
1906	26	24	32	25	.....
1907	24	26	32	28	.....
1908	27	30	32	26	.....
1909	25	.....	26	21	24

The figures in this table should not be taken too seriously, for the amount of cold an orange tree may endure without injury cannot be determined by a thermometer alone but should be taken in connection with the degree of dormancy of the tree at the time of the freeze, the condition of the weather just preceding the freeze, and the number of minutes or hours during which the very low temperatures continue. It is the writer's observation that, considering their condition, the scattering orange trees in the Imperial Valley, taken as a whole, came through the cold snap of 1910 fully as well as trees of the same age and size in the older orange sections of Riverside and Redlands.

It has sometimes happened that citrus trees have the fruit disfigured by the severity of the winds. It is therefore advisable to protect orange orchards by windbreaks of eucalyptus or other trees. In old orchards the windbreaks are not so necessary, as the injury is confined largely to the outside rows. The young trees are often badly whipped by the wind, however, and some protection is very desirable.

At the present time there are no citrus scale insects in the Imperial Valley, and the County Horticultural Commission is charged with the responsibility of preventing any such pests from gaining a foothold. This, of course, means that no costly fumigation or washing and brushing of fruit is necessary, and one of the heavy expenses connected with the production or oranges in many other parts of the State is entirely obviated.

About the only serious orange insect pest in the valley is the *thrips*. These small insects scratch the surface of the young and tender fruit and leaves, causing unsightly scars which tend to reduce their selling value. Much investigation work is at present being done by specialists looking toward a remedy for this pest.

As stated above, the Washington Navel (with some of its forms, such as the Navelencia), is the most promising variety for commercial planting. Many other varieties, however, may be grown in gardens for home use, such as *Sweet Seedlings, Valencia, Mediterranean Sweet, Paper Rind, St. Michael, Ruby Blood, Jaffa, Pineapple*, and others. In the coldest localities in the Valley the *Bigarade* or Sour Orange may be grown as an ornamental. A large number of trees of sour oranges grown in the yards in the towns would add a distinct attraction and act as a suggestion of the orange orchards in the more favored localities.

In conclusion, we may state that the Imperial Valley offers to experienced citrus growers with considerable capital an attractive field for the cultivation of Navel oranges. We would not, however, advise

a new settler unacquainted with the business and with limited capital, to stake his all on a venture of this nature where at present both the prospects of profit and the uncertainties involved seem large.

PEACH.

From the data available, it is clear that up to the present time peaches have not been a great success in the Imperial Valley. Some peaches are grown for home use, but a great many failures have been reported. It seems that as a rule those varieties which put out leaves and bloom very early are most successful. The trees grow vigorously enough and seem to endure the climatic conditions well, the chief complaint being that they bear very little fruit. The early blooming varieties are more susceptible to frost injury, but they usually bear more fruit than those which bloom later, when the air is so dry and hot that pollination is interfered with. Such varieties often produce quantities of very small, inferior, and often double fruits which have abortive pits. The trees suffer more or less from sunburn of the trunks, unless headed very low and pruned to thick compact heads. Crown gall of the roots has also been reported from several sources and there is at present no very satisfactory cure for this trouble.

It is, therefore, a question which will have to be answered in the future, as to whether commercial peach culture for shipment out of the valley will ever be a paying industry. It is quite likely, however, that the country will produce sufficient peaches for home consumption. A large number of varieties should be tested out in the valley by the Experiment Station. It is also likely that the raising and testing of peach seedlings in the valley may yield new varieties far better adapted to the conditions than any of the older kinds. It is quite likely that some varieties of the honey peach of Florida or some of their seedlings would prove successful. Much experimentation is yet to be done with peaches before their true adaptation to the Imperial Valley is known.

PEANUT.

Peanuts are well adapted to this section, but so far have not been planted on any large commercial scale. They make a vigorous growth in the spring and summer, maturing in about five months. The yield in Imperial Valley has not been measured but will undoubtedly equal that of other good peanut sections where the yield varies from 18 to 100 bushels per acre. Any variety will do well. The most common varieties are Virginia Red, a Tennesee white variety and Jumbo. The

tops make good hay which is well relished by stock and is good feed for hogs. Being a legume, the plant improves the soil by adding nitrogen. On this account peanuts may prove to be a valuable intercallary crop.

Seed is usually planted in March after all danger of frost has passed. Care must be taken not to break the inner coating of the peanut when shelling it. The seed is planted either in ridges or in hills, usually the former, the furrows being 24 to 26 inches apart. The seed is covered about 2 inches deep and irrigated well to keep up a good growth, the frequency of irrigation depending largely upon the nature of the soil. The field should be cultivated after each irrigation until the vines are too large. When the young shoots begin to go downward, some earth should be shoveled onto the center of the plant to hold the stems close to the ground. If this is not done the crop is often a failure. Light sandy or medium soils are best adapted for peanuts.

PEAR.

The data which has been collected in regard to pears in Imperial Valley is very conflicting and it is therefore difficult to form a reliable judgment in regard to the future of this fruit. Wherever proper care has been given the trees, the reports are encouraging.

In general, pears seem to endure well the climatic conditions and make a rather slow but healthy growth. The blossoms are seldom killed by spring frosts and the trees bear young and set full of fruit wherever the proper varieties have been planted together and cross pollination insured. While a large number of varieties bear fruit of excellent quality, interest centers chiefly on the Bartlett variety, which is the great pear of commerce. Reports of successes and failures with the Bartlett are about evenly divided. Bartlett trees may begin to bear fruit the second summer. Some trees were observed to bear from six to thirty pears the third summer. There is a marked tendency for the Bartlett to bloom continually during the spring and summer months, fruit being found on some trees in all stages, from blossoms to ripe fruit as late as October 10th.

Some trees, said to be of the Winter Bartlett variety, bear well, the fruit being ready to harvest the middle of December. The Madeline and Clapp's Favorite are summer varieties too soft for shipment but very desirable for home use. The Keiffer and LeConte ripen in July and August and may be expected to bear well.

The variety which has proved more generally satisfactory than any other shipping pear in the Colorado and Salt River Valleys of Arizona is the Winter Nelis. Trees of this variety grow to be of large

size and produce regularly. The fruit ships well and coming at a time where there are few pears on the market usually brings good prices.

There have been no reports of pear blight in the Valley up to date, although it would not be safe to say that it does not exist there. It is to be expected, however, that on account of the dryness of the air and the brightness of the sunlight, this disease which is so destructive in moister regions will cause relatively little loss in Imperial Valley.

PEAS.

Garden peas do very well during the cooler parts of the year, but do not endure the heat of late spring or summer. The seed can be planted any time after the first of September until February, the best time being September or October, when green peas can be had by November or early December. A good many of the plantings were killed or injured last year (1909) during the coldest weather. They should receive plenty of water, the usual practice being to irrigate every ten days to two weeks, the amount of water applied depending a good deal upon the physical nature of the soil. The medium soft soil produces the best results. The seeds are usually planted in rows from 2 to 3½ feet apart; sometimes two rows being planted on one ridge.

The *Yorkshire Hero* is the most commonly planted, although *Telephone, Stratagem, Gradis,* and *Champion of England* all give good results.

It is possible that the raising of winter peas for shipment north and east and even for canning may assume large proportions in future.

PECAN.

The pecan is native to the moist alluvial lands along the river bottoms of southern States. While it is distinctly out of place in Imperial Valley, dooryard trees may be grown and a good quality of nuts produced, provided an abundance of water is supplied. On account of the cost of land and water it is quite out of the question to attempt to grow pecans for sale and thus compete with the cheap wild lands of the south. Seedling trees seem to make a better growth than grafted trees, although the reason for this is not obvious and the question has not been subjected to an accurate test.

PEPPER.

Red Peppers or Chili are well adapted to Imperial Valley, but up to date not enough have been produced in the Valley to supply local markets.

The seed is planted in hotbeds in January and as soon as danger of frosts is past the seedlings are transplanted into permanent rows in the field. The pepper requires much water and during mid-summer should be irrigated weekly. Picking begins the latter part of June and continues until frost kills the plants in the fall. Medium soft soil comparatively free from alkali is best, for the pepper plant is quite sensitive to alkali.

No insects or diseases have so far been reported.

PERSIMMONS.

Information concerning persimmons in the Imperial Valley is very meagre, very few trees having ever been planted. It is the opinion of the writer, unsupported by data, that most of the cultivated varieties of American persimmons, such as the Josephine, Miller, and Lonestar, will succeed fairly well, provided plenty of water and reasonable care is given them.

Mr. F. Heiny of Brawley has tested two of the Japanese varieties, the Tane Nashi and Hashia, and reports that both do well, producing abundant fruit of good size and fine flavor.

PINEAPPLE.

The pineapple succeeds best in a tropical and sea-coast climate, where the air is laden with moisture from the sea and frosts are absent or very light. It would seem, therefore, that the pineapple would be decidedly out of place in the dry air and hot sunshine of the Imperial Valley. It is very doubtful as to whether the plants can thrive and fruit in the open ground. It may be possible to construct shelters covered on the top and sides with muslin which may screen out part of the light and withhold a part of the moisture evaporating from the soil. Under such artificial conditions it may be possible to grow the plants to fruiting. It is most probable, however, that the cost of the crop grown under such conditions would far exceed its market value.

PLUMS AND PRUNES.

The different species of plums, and even in some cases the different varieties, react very differently to the climatic conditions and environment of Imperial Valley. Very much work in testing varieties and new seedlings has yet to be done before anything approaching a complete report can be made. The remarks following should be taken as a summary of indications based on such evidence as is available at the present time.

As a rule, the varieties derived from American and Asiatic species and hybrids between these species succeed much better than the European varieties. Such varieties as Lombard, Bradshaw and the various prunes either fail entirely or produce so little fruit as to be unprofitable. On the other hand, a number of American and Japanese plums succeed admirably and produce heavy crops.

The variety which has been observed to succeed best is the Marianna, which is a hybrid of Myrobalan and Chickasaw. This is a small red plum ripening in early May, which is especially suitable for jellies and preserves. It grows readily from cuttings. Other promising varieties which are suggested for trial as likely to be profitable are: Red June, Satsuma, Doris, Gonzales, McCartney, El Paso, Wildgoose, Wickson, Climax, Chalco, Burbank and Chabot.

All plum trees in Imperial Valley should be headed low and pruned so as to provide shade for the trunks and main branches. The two great foes of the plum in the eastern states, the curculio and brown rot, are not known in Imperial. The roots are subject to crown gall disease, though not to a serious degree. Plum culture in the Imperial Valley appears to us as an inviting field for experiment.

POMEGRANATE.

The pomegranate, coming as it does from Palestine and northern Africa, finds a congenial home in the Imperial Valley. The plant thrives wonderfully and fruits heavily, not being over particular as to soil or a moderate amount of alkali. It will live without water for a considerable time, but fruits best when well irrigated. No especial pests of this plant have been reported, about the only trouble encountered being a cracking and splitting of the fruit just before maturing. All varieties succeed, but the variety called "Wonderful" is the most handsome and prolific known by the writer. The plants strike root readily from cuttings and are therefore very easily propagated.

Americans do not seem to appreciate this delicious and refreshing fruit as the Mexicans do, and it is as yet hardly known in the northern markets. It is quite likely that with a little enterprise shown in packing and marketing, that this fruit would find a market at least for purposes of decoration. They would reach general consumption later as the people grew to know them. However, be this as it may, it is certain that any family living in Imperial Valley and failing to grow a few pomegranates for home use is missing one of the opportunities of the country.

POMELO (*Grape Fruit.*)

What was said in regard to the growth of oranges will apply almost equally to pomelos. There are a number of thrifty and productive dooryard trees bearing fruit in the valley, but no commercial orchards

Fig. 44.—Pomelo tree in fourth summer. Date seedlings in the foreground.

have been planted. So far as known, pomelo trees in Imperial Valley have no serious insect pests. The fruit ripens rather early, is of fair quality and could no doubt be disposed of to advantage in the northwestern markets. Desirable varieties are Marsh's Seedless, Duncan and Triumph.

POTATO (*Irish Potato.*)

As yet, most of the Irish potatoes consumed in Imperial Valley are shipped in from the coast, for the climate is not well adapted to the culture of this crop. The potato plant being sensitive both to the cold of winter and the heat of summer has a very short season in which to mature. They may be grown either in the spring or fall, spring being preferable.

Soft soil is of course best, but a fair quality of tubers may be produced on the heavy soils. The seed is planted about the first of February in soil still moist from previous irrigation. The ground is watered soon after planting and again after the plants appear. Plenty of water is given during the growth of the vines, but it is gradually withheld as the plants near maturity.

It is practically impossible to keep potatoes for seed over the winter; in fact, the crop should be harvested and consumed as soon after maturity as possible to prevent loss from rapid decay.

The yield is usually light as compared with other regions, but some heavy crops have been reported. The varieties commonly grown are Burpee's Extra Early, Early White Rose, Triumph and Salinas.

PRUNES (*See under Plums.*)

PUMPKIN.

Although but little grown, the pumpkin is well adapted to the country. If planted in June or July the vines will grow throughout the summer and mature fruit before frost. We are unable to secure data on varieties as the pumpkins grown in the valley were not grown under name. They are used chiefly as a supplementary food for milch cows.

QUINCE.

Quinces flourish and produce heavily in Imperial Valley whenever they are given sufficient water. They withstand admirably the heat of summer provided they are headed low and so pruned as to provide shade for the trunk. Quinces are not overly particular as to the quality of soil and are quite resistant to alkali.

So far as known, quinces have never been injured by the cold of winter and it is very rare that their blossoms are killed by spring frosts. Owing to the fact that they are used almost exclusively for jellies and preserves, there is not a great demand for the fruit on the open market. Abundant fruit for local markets and home use may, however, be produced with ease. Varieties suggested are Orange, Champion, Smyrna, Meech's Prolific, Rea's Mammoth and Pineapple.

RADDISH.

All kinds of radishes so far tested seem to do exceedingly well when grown during the cool part of the year. Seed may be sown in succession from late August till April. Fair yields are usually secured and no particular skill is required to grow the crop. Soft soil is, of course, most desirable.

RASPBERRIES.

Raspberries are native to cool countries with a humid atmosphere. They are very difficult to grow in the Imperial Valley and all attempts to grow them, so far reported, have failed.

RHUBARB.

Rhubarb makes a fair growth in winter but the plants die out in summer unless considerable expense is incurred to shade and protect them from the hot sun. In fact, rhubarb is so out of place in Imperial Valley that it is not worth while to attempt to grow it.

RICE.

In 1904 some rice was grown in Imperial Valley as an experiment and seemed to be a partial success. The rice plant will endure the climatic conditions very well but it requires large amounts of water. Whether rice culture will ever amount to anything will depend largely on the economic conditions.

ROSELLE.

This is a plant long cultivated in India for its fiber, but recently introduced into this country and cultivated for the red fleshy calyces which are used in making a fine quality of jellies and jams. Sauce made from it may displace cranberry sauce. It is an annual plant, somewhat resembling cotton in size and manner of growth. It is well suited to the conditions in Imperial and has been reported as making a very satisfactory growth and producing well. No pests are at present known and the plant deserves a wider planting.

Seed should be sown in beds under cover and the plants set out as early as danger from frosts is over. The product is harvested in October, November and until the plants are killed by hard frosts.

SALT BUSH.

The Australian Salt Bush (*Atriplex semibaccata*) is well adapted to the climate and has produced well wherever tried. It is fairly drouth resistant, but its special value lies in its resistance to alkali.

It will grow well on lands which are too salty for alfalfa. As a forage crop it is of course inferior to alfalfa, but is fairly well relished by sheep and by stock when mixed with alfalfa or other hay. It is not recommended, however, as a desirable crop on good soil.

SESBANIA.

Colorado Hemp (*Sesbania macrocarpa*) is a plant native in marshy land from Pennsylvania through Texas, Arizona, and Mexico to Panama. The conditions along the Colorado River are unusually good for this plant and almost impenetrable jungles of it cover large areas of the delta lands. It grows ten or more feet high and, being a legume, bears large nodules on its roots. It requires a great deal of water. Several attempts have been made to utilize the strong fibre in the stems but perhaps on account of the lack of effective decorticating machinery these attempts failed.

This plant should be tried as an orchard cover crop. Although it makes a very tall growth the stalks are easily reduced to fineness by a drag and disc harrow. Seed should be sown in July.

SORGHUMS

Broom Corn	Durras
Kafir Corn	Sweet Sorghums

The sorghums are all well adapted to Imperial Valley and are grown to a considerable extent. Unlike Indian corn, they thrive best during the hot summer months and do well on all soils, unless alkali is unusually strong. The medium loam gives the best results. Frost prevents growth in the late fall or winter. The seeds germinate from the first of April until November and can be planted any time after the daily temperature reaches 85° or above until the last of July. If forage only is desired, August would not be too late. The middle of June is the most common time for planting. Sorghums often follow a spring crop such as barley or cantaloupes. The yield varies from one to four tons of fodder per acre, or from 1,000 to 2,500 pounds of grain. When unthreshed the yield is from one to one and three-fourths tons per acre.

Sorghum fodder is inferior to alfalfa hay but is an excellent substitute for it during the hot summer months. The cost of raising this crop is slight as it needs little attention. Proper care, however, pays in larger and better yields. Two or three cultivations with less frequent irrigations would improve results, although the cost of labor during the summer months may prohibit such practice. The cost

of harvesting the seed is sometimes excessive, as the heads have to be cut by hand and on this account it is coming to be used more for fodder than for grain.

The seed is usually drilled in rows 3 feet to 3½ feet apart and from 6 inches to 18 inches in the rows, when grown for grain. It is sown broadcast or drilled when the fodder is to be cut or when the field is to be pastured. The seed can be planted with the ordinary grain drill when a thick stand is desired by stopping up the alternate holes. From 3 to 6 pounds of seed are used when drilled and from 6 to 15 when broadcasted. The seed bed should be well prepared by plowing and thorough discing, although seed is often planted on old barley land by simply discing the seed in after broadcasting.

Irrigation usually proceeds and follows seeding and whenever the plants show a need thereafter. It is well to keep the soil well moistened during the first month of growth, as the sorghums all start slowly. Three thorough irrigations, given when the plants are young and again when they head out, have proved satisfactory on sandy loam where the moisture has been well conserved. On other soils irrigations come every ten days to two weeks. Too much irrigation often induces too much growth of stalk. The sorghums will stand some drouth and will start growth immediately on the application of water. The best growth and yield comes when the growth is uniform throughout the season. The plants will endure much more alkali than alfalfa. The crop responds, however, to good soil and to good treatment.

Small black flea beetles often attack the young plants and do some damage at that time. No remedy is known at present. Blackbirds and turtledoves take a good deal of the grain of the White Egyptian Corn.

Broom Corn.—Broom corn has been grown here in a number of small patches and has made a strong growth of head and produced a good yield when properly handled. Both the dwarf and the standard varieties have proved successful. The expense of producing and marketing it in the face of uncertain prices has been the main factor in preventing its culture on a large commercial scale. An average yield of 400 pounds of brush has been secured from the dwarf corn.

Kafir Corn.—The White, Red and Black-hulled Kafir corns are all grown here, but the Red predominates. It furnishes the best crop of all non-saccharine sorghums for fodder, as the leaves are large and numerous and the grain yields well. The seed matures in 12 to 14 weeks but the stalks remain green much longer, which gives it an advantage over the Durras or the saccharine sorghums for fodder. The

field should be cut when the grain is ripening and allowed to cure to get the best fodder. The kafirs are seldom cut for the grain. Ten to twelve pounds of seed are usually broadcasted and harrowed in. When drilled three to six pounds are sufficient.

Sweet Sorghums.—The early Orange and the Early Amber are the most common of the Saccharine Sorghums. Any of the six or eight varieties will do well, however. Good syrup can be made but most of the sorghum is used for pasture, soiling or forage. The heads are not generally harvested for the grain as the seeds are small and the percentage of hulls to grain is rather large and the hulls are somewhat astringent. When used for soiling, the best results are obtained by cutting when almost mature. The second growth sorghum (if at all stunted) is apt to poison stock on account of the relatively high content of prussic acid. The poisoning does not generally occur if the sorghum is in good growing condition. Injury to land for future plantings of barley is often reported. The reason for this injury is not definitely known, but is probably due to shallow plowing before planting the barley. The numerous surface roots of the sorghum decay slowly and may possibly have a poisonous effect. Alfalfa is not injured in the least, in fact, sorghum is considered a good crop to precede a planting of alfalfa.

Durras.—The yellow or dwarf Milo Maize, White Durra or Egyptian Corn and the Brown Durra all do well and are generally grown for grain rather than for forage. The heads are larger and the seeds larger and softer than those of kafir corn or sorghum, but the stalks are less leafy and more mature and dry when the seed ripens than are the stalks of kafir or sorghum. Twenty pounds of alfalfa and eight to nine pounds of corn form a splendid feed for dairy cows. The heads of the Durras are pendent which makes harvesting rather difficult. The stover is of little value. The Dwarf Milo is the most popular, as the heads are lower and more easily cut; the seed does not shatter and the yield of seed is good. The unevenness of the height of stalks in thin planting makes harvesting difficult. This condition can be partially remedied by thick planting, which makes the stand more uniform and the percentage of pendent heads less. The heads are usually fed unthreshed. The White Durra or Egyptian yields the best and the grains are larger and better liked than the Milo Maize, but the easy shattering of the seeds and the amount lost through attacks by birds, especially the blackbirds and turtledoves, make it less desirable than Milo. The Brown Durra is little grown.

SPINACH.

This delicious vegetable may be grown during fall, winter and early spring with the greatest ease. It does best on soft land which has been well manured. Seed may be planted from early September to February. It requires an abundance of water. All varieties do well.

SQUASH.

The squashes are quite tender to frost but resistant to heat. Both the bush and running varieties may be planted in late February or early March. They require soft, rich land with plenty of water for best development. Growth is checked somewhat by the dry hot weather of June and July, but some kinds, especially the running varieties, will live over the summer and produce a second crop in the fall. The summer squashes, such as Yellow Crookneck and Mammoth White Bush, do much better than the winter squashes commonly grown in the north.

STRAWBERRIES.

Successful strawberry culture in the Imperial Valley is beset with difficulties and a great deal of skill is required to produce berries on a commercial scale at a profit. Those who acquire the necessary skill, however, may grow good crops of strawberries of high quality. There is not so great an incentive to grow strawberries in Imperial as there is in the Salt River Valley of Arizona, for the reason that large quantities are shipped in from the coast and sold at very reasonable prices. Still fresh, plump, home-grown berries command a considerable premium over the coast grown product. In most situations there are too many frosts to permit of winter berries and the regular spring crop does not ripen very much earlier than the crop on the coast.

The strawberry plant grows thriftily throughout the winter, but it is always difficult to carry young plants through the heated summer season. February is the best time to set young plants. One of the most important requirements is a constant water supply. *Strawberries should be irrigated at least once a week and, if possible, every four or six days.* After the plants are well established they will continue to bear well for four or five years.

It is also very important to select varieties which have been found to do well in the region. Such varieties are very few in number. The Arizona Experiment Station made an exhaustive test of strawberry varieties and the experience so far gained by Imperial Valley growers shows that the Arizona findings are in the main correct and

Fig. 45.—Strawberries in the Colorado River Valley near Yuma. The variety is Arizona Everbearing.

applicable to Imperial conditions. Perhaps the most generally satisfactory variety is the Arizona Everbearing, which may be harvested from January to May. The Lady Thompson is good but the picking season lasts but three to four weeks. Other desirable varieties are Michel's Early, Texas and Excelsior. Growers report that such varieties as the Brandywine grown so largely on the coast die out entirely during the first summer.

It will be seen from the above discussion that it is extremely unlikely that strawberries will ever be grown for shipment out of the Valley, and there will probably not be very many grown for local markets. Those who insist on growing strawberries in the Imperial valley, and there will probably not be very many grown for local and develop sufficient skill in watering and handling the crop.

SUGAR CANE.

Sugar cane, or ribbon cane, has been tried on a small scale and has proved quite satisfactory. No large area has been planted on a commercial scale as yet, partly on account of the existing economic conditions, but there is little doubt but that it would pay in a small way if a market for the fresh cane was near. The Florida cane is the only kind planted so far. Sugar cane is very successfully propagated by planting the eyes or joints, as is done in the south. The sugar content is reported high and some excellent home-made syrup has been produced. Sugar cane stands considerable alkali and does well on both medium hard and medium soft soils. The irrigation of sugar cane is practically the same as for sorghum.

SWEET POTATOES.

Sweet Potatoes grow exceedingly well in Imperial Valley; so well, in fact, that they are considered as weeds by some people. The roots often live over in the soil for several years and continue to grow until they assume tremendous proportions and are fit subjects to cause wonderment at any county fair. Such holdovers are woody, however, and unfit for food. It sometimes happens that the small potatoes left in the soil sprout up continually from year to year and are difficult to eradicate from gardens and along ditches.

The seed potatoes are planted in subheated beds in February and set out into the field when the slips are large enough. Soft land is much the best, as hard soil causes the potatoes to be very rough and misshapen. No serious pests have been reported so far. All varieties seem to succeed. Those commonly grown are White Vineless Yam, Southern Queen, Shanghai, Jersey Red, Yellow Jersey and others.

TOBACCO.

Tobacco has been tried in a small experimental way in Imperial Valley, but it has not been grown sufficiently to warrant commercial plantings. In the tests made Sumatra and Cuban made a fair growth and produced a leaf of fine quality. Great damage is done by the wind in whipping the leaves to pieces.

TOMATOES.

The spring and fall climate of Imperial Valley is well suited to the growing of tomatoes; although the plants are sensitive to the intense heat of July and August they will live through this period and start a fresh growth in the fall. The plants are also sensitive to cold, but will not be killed except by temperatures below 32°. Dwarf Champion and Stone are the varieties chiefly grown. The Earliana is apt to sunburn; the Bulgaria has not given very good results.

Tomatoes are generally started in covered seed beds in well prepared soft soil, but are sometimes planted directly in the field. In Arizona this proved to be the best practice, as the transplanted tomatoes lose all they gain in the early growth due to the check following transplanting. They are usually planted in the early spring, sometimes as early as February and usually before the first of May. If started in seed beds transplanting takes place in a month or six weeks, when the plants are six to eight inches high. They should be allowed to grow rather large, so that the stems will be slightly woody before transplanting. The plants are set out in rows from four to six feet apart and from eighteen inches to two feet in the row. Tomatoes should receive plenty of water to insure a vigorous growth, but care should be taken not to scald the young plants on hot days. Damping off is uncommon. If plants go too much to vine it is well to partially cut off the water to make them start fruit buds. If planted early, tomatoes begin to set fruit in the first part of the summer, the first tomatoes ripening about the middle of May and continuing well into July, when the hot weather precludes further growth until the latter part of August. The fall blossoms appear the latter part of September and picking can begin about December first and continue on through the winter or until the vines are killed by the frost. Soft sandy soil is best adapted for tomatoes, although good growth is made on medium hard soil. The corn ear worm does some damage and the large tomato worm does considerable injury to the plants.

TURNIP.

Turnips easily endure the cold of winter, but are killed by the heat of summer. They are therefore very easily grown during the cool part of the year, their culture being very simple. Seed is planted at any time from October to March, either in rows and watered through furrows or broadcasted and flooded. They require an abundance of water in order to grow rapidly and produce crisp tender roots. No serious pests have been reported. All varieties succeed.

VELVET BEAN (*See under Bean.*)

VETCH.

Common vetch (*Vicia sativa*) has been tried in the valley with variable results. Some report success and others a failure. As the plant is killed by very hot weather it should, of course, be grown during the winter, being planted in October or early November. Much experimentation is yet to be done with this plant. If it can be made to grow it will be a valuable addition to the list of winter leguminous cover crops for orchards.

WALNUTS.

English walnuts are very poorly adapted to the Imperial climate. They thrive best near the Coast where the sea breezes are damp and cool. A few specimens of the English walnut have been planted in the valley and they seen to be making some growth, although the foliage sunburns badly. It is likely that when the trees begin to fruit the nuts will also sunburn and the meats turn dark. Sunburn causes the hulls to adhere so closely to the nuts that they have to be hulled by hand.

It is likely that trees of the native Arizona black walnut (*Juglans rupestris*) may be grown fairly successfully for ornament and shade.

WATERMELON.

Watermelons are well suited to the Imperial Valley. The vines grow vigorously and produce abundantly of high quality melons. Seed is planted in March after all danger of frost is past, the subsequent treatment being much the same as for cantaloupes, (*which see*). Watermelons are grown extensively for home use and local markets, but commercial shipments out of the valley are limited to the earliest markets. The first shipments are usually made during the last week in June.

The quality of the melons is very good at first, but deteriorates during the very hot weather of July. Sometimes the vines are cut back in August, the land cultivated, refurrowed and irrigated, after which a new growth will start and melons of good quality will ripen in October and November.

A large list of varieties are grown, among which may be mentioned Kleckley Sweet, Florida Favorite and Sweetheart.

WHEAT (*See under Grain.*)

THE WEEDS OF IMPERIAL VALLEY.

Weeds have been introduced into the valley largely through the irrigation water and by importing impure seeds. In spite of the strictest regulations regarding the inspection of seed and the cleaning of ditch banks, these sources of weed infestation cannot be entirely controlled, at least until the land is more intensively cultivated. It is only through careful co-operation among all of the land owners of the valley that the work of exterminating the obnoxious weeds will be at all satisfactory, as the weeds quickly spread from the badly infested farms to the neighboring clean land. The County Horticultural Commission has declared the following weeds a public nuisance and injurious to the agricultural and horticultural interests of the county: *Johnson Grass, Dodder, Wild Morning Glory, Cocklebur, Wild Asparagus* or *Spring Aster,* and *Wild Sunflower.*

The following summary gives the best methods of eradicating these and other pestiferous weeds found in the valley:

Johnson Grass (*Sorghum halepense*) should be cut before blooming, the earlier the better, to prevent seeding and the formation of any strong new root stocks which would form the main root stocks for the succeeding year. The old root stock dies each year so that by carefully keeping the grass cut down or eaten off, the plants can be exterminated in two or three years' time. Infrequent cultivation spreads the root stocks and causes more harm than good, but thorough and constant cultivation to keep down any growth that may appear will prove successful. Close pasturing with hogs or cattle will eventually kill out this grass.

Wild Morning Glory (*Convolvulus incanus*), sometimes known as bind weed, can best be eradicated by hoeing up the plants and then either burning or drying them in the sun. As soon as new growth

appears is should be cut out as soon as possible. Thorough cultivation after that will prove beneficial, but cultivation before the hand hoeing is apt to spread the vines and cause a wider distribution of the pest. Deep plowing helps but little.

Pig Weeds (*Amaranthus sp.*) are hard to eradicate because of their rapid growth and because seeds from distant sources are carried onto the fields by irrigation water. The only way to keep them down is by cutting or pulling the young plants before they bloom, thus preventing the formation and spread of seed. This must be done every year, however, because the land is apt to be reseeded through the irrigation water.

Bermuda grass (*Cynodon dactylon*) can be killed out by thorough cultivation and summer fallowing where the land is not subirrigated. Where the land is subirrigated the eradication of this grass is expensive and very tedious.

Dodder (*Cuscuta epithytum*) can best be killed out by burning.

Fig. 46.—Cocklebur from side of road which germinated, grew and matured three seeds, the soil having been once slightly wet with waste water.

Fig. 47.—Running Malva.

An easy way is to pile dry hay on the spot and set it on fire. This should be done as soon as the dodder appears, as it spreads rapidly.

Cocklebur (*Xanthium canadense*) must be prevented from seeding and to do this considerable watchfulness is necessary, as the plants grow rapidly and produce seed when very young. This is especially true in the fall when the cockleburs are apt to come up and go to seed unnoticed. They should be pulled up as soon as seen and if seed have formed they should be burned. Two years of thorough work is often needed, as the seeds are long lived. Rotation of crops and clean culture is one of the best methods of combating the cocklebur.

Running malva (*Sphaeralcea augustifolia*) or snuffle weed, as it is sometimes called, is a pernicious weed to eradicate, which requires considerable patience. The seeds mature quickly and continually and constant and thorough cultivation is necessary to prevent reseeding. The easier way is to cultivate the plants out while still young before coming into bloom.

Wild asparagus or *Spiny aster* (*Aster spinosus*) spreads both by

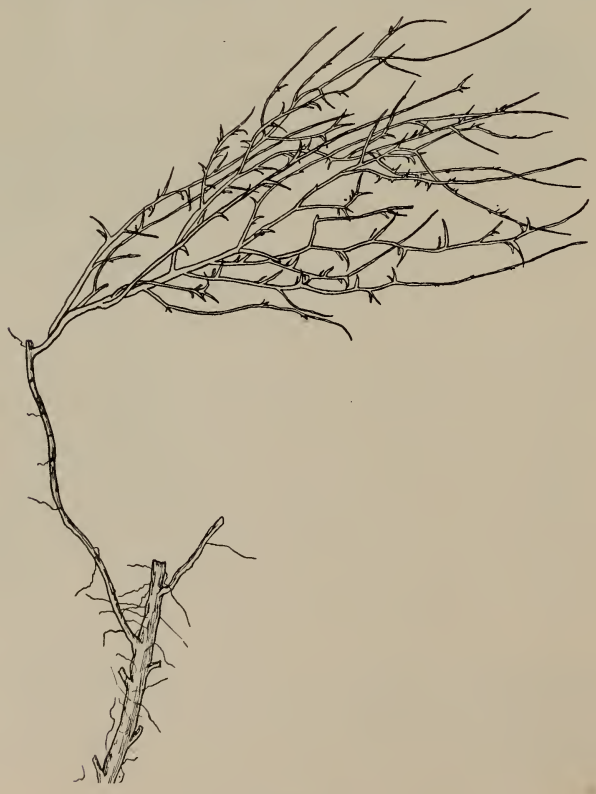

Fig. 48.—Wild asparagus or spiny aster.

seed and by underground root stocks, hence the method of fighting it must be similar to that recommended for Johnson grass. Plowing a field will kill some of the plants, but to exterminate the pest, the tops must be *kept down,* so that no green shows above ground and no food can be stored in the roots to sustain life for further growth. The process of cutting down this weed as often as it appears above ground is a very tedious one, but if conscientiously followed will be successful. The easiest and cheapest way, perhaps, is to plant alfalfa and cut hay two years. This will reduce the hand work to the wild asparagus along the ditches and under the fences.

Wild Sunflower (*Helianthus annus*). This is easier to fight than any of the other weeds mentioned, as it is more easily prevented from going to seed if ordinary care is used.

Foxtail (*Hordeum jobatum*). Rotation of crops is perhaps the best method of combating the foxtail. There is no other successful and economical way of getting rid of this pest when once established in an alfalfa field. By cutting the first crops before the foxtail ripens, good feed may be secured. If cut after ripening the awns of the foxtail work into the gums of stock and cause much sore mouth.

Star thistle (*Centaurea melitensis*). Thorough cultivation and rotation of crops will kill out this weed. The young plants should not be allowed to go to seed.

Other weeds which are sometimes troublesome in the southwest and which should be guarded against, are:

Pignut, *Caesalpina falcaria pringlei.*
Velvet weed, *Gaura parviflora.*
Knot grass, *Paspalum distichum.*
Switch grass, *Festuca fascicularis.*
Nut grass, *Cyperus esculentus.*
Smart-weed, *Polygonum lapathifolium.*
Skeleton weed, *Eriogonum deflexum.*
Salt weed, *Suaeda torreyana.*
Tumble weed, *Amaranthus albus.*
Horehound, *Marrubium vulgare.*
Devil-claws, *Martynia fragrans.*
Horse nettle, *Solanum elaeagnifolium.*
Jimson weed, *Datura meteloides.*
Morning glory, *Ipomea Mexicana.*
Small tumble weed, *Krynitskia crassisepala.*
Beggar's lice, *Echinospermum redowskii occidentale.*

Herbicides.—Thorough cultivation, short rotations and prevention of seeding are the best methods of fighting weeds. Still in some cases chemicals may be used to advantage, especially under fences and in places where it makes no difference if nothing grows. Some of the herbicides not only kill the weeds, but poison the soil to such an extent that nothing will grow. This would make no difference in the case of fence rows, walks, roadsides, etc.

Salt (dry or in concentrated solution) acts the same as other alkalis.

Blue vitriol is a good herbicide but is too costly for ordinary use.

Kerosene.—This is rather weak in efficiency and sometimes dangerous.

Carbolic acid.—This is one of the best herbicides, as it acts quickly and the crude acid is cheap.

Sulfuric acid.—Effective, but not generally recommended.

Caustic soda.—Used for deep rooted or woody plants.

Arsenical compounds.—These are lasting and very effective. (White arsenic, 1 pound, washing soda, 2 pounds; water, 3 to 9 gallons).

Distillate.—This has been reported as being very effective, and as it may be secured cheaply, it may prove one of the best.

PLANTS FOR ORNAMENT AND COMFORT.

Plants for Lawns.

Lawns are unusually desirable in Imperial Valley on account of the dust and reflected heat from bare ground. We are somewhat limited in our choice of plants, however, on account of the fact that the blue grass chiefly used in the east does very poorly and requires more skill to start and maintain than most people care to give. A few persons have succeeded with a mixture of blue grass and white clover, but such cases are exceptions.

Bermuda grass thrives wonderfully and makes a very good lawn, but it is so pernicious in its tendency to spread and appropriate every inch of space intended for flowers and other plants, and it is so feared by farmers that it has but few friends in the valley. In the city lots of the Salt River Valley of Arizona, under similar conditions, Bermuda is largely used for summer lawns. In the fall Australian Rye Grass (or Italian Rye Grass), an annual, is sown with the Bermuda and furnishes a soft velvety lawn all winter, dying down with the approach of hot weather and the renewed growth of the Bermuda.

A new lawn plant which is coming into quite general use in Imperial is the *Lippia nodiflora*. This is not a grass, but a plant allied to Heliotrope and Verbena. It spreads rapidly by runners, yet is not hard to eradicate when desired. It lies flat on the ground, making a good carpet and is covered with small green leaves all the year and with small white or pinkish flowers most of the summer.

Fig. 49.—A Lippia lawn.

A very satisfactory lawn for country places may be secured by planting small pieces of the runners about a foot apart each way and watering well until the plants have grown together and form a solid mat.

SHADE TREES.

The following deciduous shade trees are recommended for planting: Cottonwood,—some persons object to cottonwood on account of the disagreeable cotton which is shed, but if male or staminate trees, which produce no cotton, are selected from which to take the cuttings, this objection will be obviated. Arizona Ash is a desirable and satisfactory avenue tree. China Umbrella Tree is quick growing, hardy and produces a dense shade. It is liable to be broken to pieces by the winds unless carefully pruned each winter. The true China tree produces little shade and is not nearly so satisfactory as the umbrella variety of the China Tree. Mexican Elder is a small tree which puts out fresh green leaves very early in spring and is covered with white

blossoms in summer. Honey Locust grows well and is useful for variety sake. The various kinds of Mulberry succeed admirably, although some persons object to the litter made by the falling fruit. Among evergreen trees the following are suggested: Pepper tree,—this is one of the most beautiful and generally satisfactory ornamental

Fig. 50.—Cottonwood tree, a very rapid grower.

evergreen trees available for Imperial planting. Several kinds of Eucalyptus (see under Eucalypts). *Sterculia diversifolia* or Australian bottle tree, Monterey Cypress, Chinese Arbor Vitae, Mission Olive, Washington, Canary and Date Palms. Other trees, such as the Carob or St. John's Bread, Live Oaks, Pecans, etc., are being experimented with and may prove valuable. Bagote trees thrive in the region and are beautiful and interesting, although they furnish very little shade.

SHRUBS.

Shrubbery is very useful for planting at the sides of the house and for banking along the borders of the front lawn as a boundary and to act as a background for the flowers. Pomegranate, *Euonymus Japonica,* and the Japan privet *Ligustrum Japonicum,* are especially

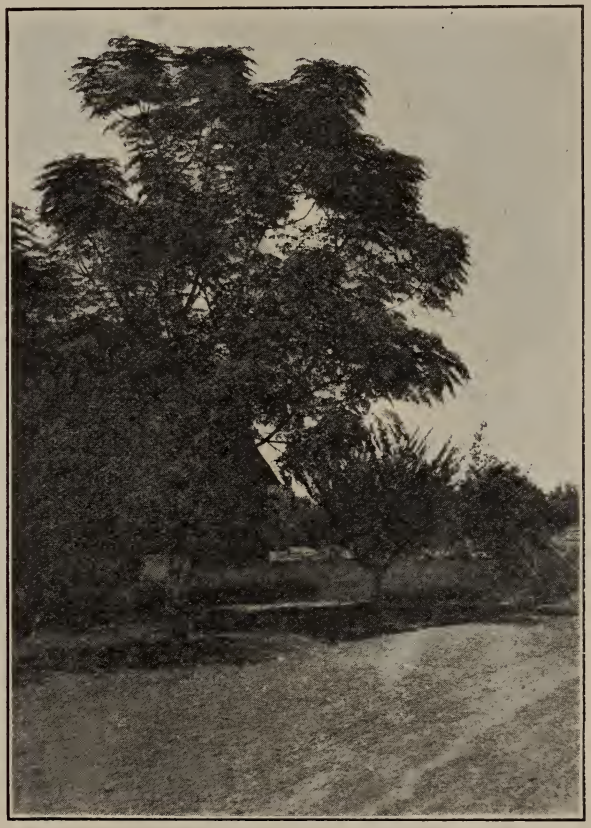

Fig. 51.—Old-fashioned China tree, the kind to avoid.

suitable for this purpose. Quick growing shrubs are also useful in screening ugly outbuildings or undesirable views. The giant reed *Arundo donax,* and castor bean are very quick growers, and both thrive in the climate. With these two plants available and so easily grown, there is really no excuse for such things as the cow lot, pig pen, etc., being in view from the dining room or living room windows. The oleander in many varieties makes excellent growth and blooms

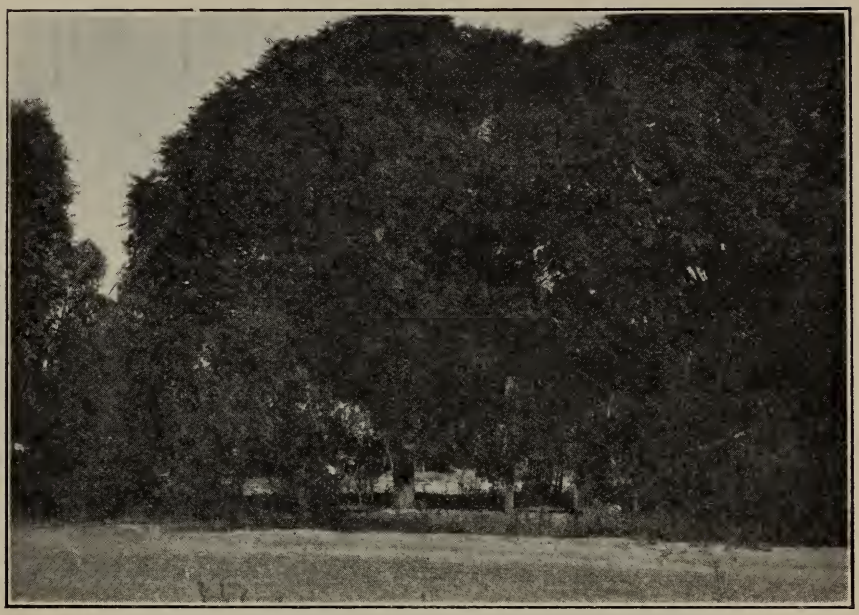

Fig. 52.—The Umbrella variety of China tree. A vigorous grower and dense shade tree, but short lived and easily broken by the wind.

Fig. 53.—Four-year-old pepper trees. Quite satisfactory for ornament and shade.

profusely in Imperial Valley. About the only objection to it is that it is poisonous to stock. It is also poisonous when eaten by children, but this rarely happens, as the leaves and flowers are exceedingly bitter. Several tamarisks have also been observed to grow well, especially *Tamarix hispida* var. *aestivalis.* A large number of kinds of Cactus and Yuccas from the desert are, of course, available to those who fancy this type of ornamentals. The Squaw Bush, *Lycium gracilipes,* is well suited to the country and makes a good growth, as do also several of the salt bushes. Sweet Myrtle, *Myrtis communus,* grows very well and is valuable either as a hedge plant or as a lawn specimen, where it bears beautiful white flowers and attractive dark blue berries. The Tuna, *Opuntia tuna,* grows well, of course, and may be used both for a hedge and for its fruit.

Fig. 54.—Shade trees and vines in the Imperial Valley often constitute the chief difference between a house and a home.

VINES.

There are several kinds of annual vines which will thrive and cover an arbor or porch, but the perennial vines are, as a rule, much more desirable. If these are deciduous they will not only keep the sun out during summer, but will let the sun in during winter.

The Virginia creeper is one of the best known climbers in the United States and it thrives fairly well in Imperial Valley. One of

its valuable features is its brilliant red autumnal coloration. The silk vine, *Periploca graeca,* is a rapid and vigorous grower with bright shining green leaves and is fairly resistant to alkali. Various grapes may be used for covering arbors, the wild grape of Arizona, *Vitis Arizonica,* being one of the most drouth resistant. Hall's Honeysuckle is also a very desirable vine which is almost evergreen and is attractive on account of the fragrance of its flowers. The trumpet creeper, *Tecoma radicans,* is rather a diffuse grower and is adapted as an ornamental rather than as a sun shield. It bears large red flowers all summer. (*Tecoma grandiflora* also has attractive flowers). Other desirable vines are *Bignonia tweediana, Clematis paniculata, Partheenocissus tricuspidata* (the Boston Ivy), and the *Bougainvillea.* This latter is rather tender to frost and needs some protection on frosty nights when grown in exposed situations. In the warmest places it may be possible to grow the beautiful *Solanum wendlandii,* which bears a profusion of large blue flowers.

The most desirable vines for covering an arbor and making a sun screen here mentioned are: Silk Vine, *Bignonia tweediana,* and Arizona wild grape.

ROSES.

Many roses do very well in Imperial Valley and the total number which have been tested is large. The following are among those which have been reported as giving satisfaction: *White Kaiserine August Victoria,* a good white climber; *Lamarque,* white climber, good; *Crimson Rambler,* red climber, very good; *Etoile de France,* crimson, very good; *Gruss an Teplitz,* deep red, ever bloomer, very good; *Governor Wood,* red, very good summer bloomer; *Black Prince,* red, very good; *Papa Gontier,* brilliant carmine, very good; *Baby Rambler,* deep pink, good; *Caroline Testout, Captain Christy, General Arthur, Geo. Pernet,* pink, good; *Safrano,* deep fawn; *Madame de Watteville,* salmon white, good; *Perle von Godesburg,* deep yellow, good; *Sunset, Dorothy Perkins, Catherine Mermet, Helen Gould, Marie van Houtte, Golden Gate, Bridesmaid, Rainbow, M. P. Wilder, Mary J. Lang,* and many others.

The Mannetti stock thrives exceedingly in the soil of Imperial and most roses will do well if budded upon it. It frequently happens, however, that the great vigor of the Mannetti causes it to sucker and if the suckers are not continually cut out they will soon entirely choke out the scion.

Perennial Flowers.

One of the most satisfactory plants for permanent borders for walks and for low hedges is *Santolina incana,* commonly known as Lavender Cotton. This is a beautiful plant with silvery leaves and brilliant yellow flowers. It seems to be quite resistant to alkali, heat and dryness. Other perennial flowers are Chrysanthemums, Iris or blue flag, Canna, and Perriwinkle. True Lavender and Asparagus

Fig. 55.—A new house near Calexico, where a splendid start has been made toward an attractive home.

are also useful for filling in for mass effects. Globe Artichoke is also very useful for this purpose. So little has been done along floricultural lines in the Imperial Valley that any list given at this time must necessarily be regarded as only a partial one.

Annual Flowers.

The following partial list of annual flowers is recommended: Sweet Pea, Corn Flower, Poppy, Yellow Oxalis, Petunia, Verbena, Ten Week Stocks, Sweet William, Snapdragon, Wall Flower, Wild Marigold (*Baileya multiradiata*) and Gaillardia. For making a show of color in spring and early summer the following four can hardly be excelled. Petunia, Marigold (*Calendula officinalis*), Ten Week Stocks and Snapdragon (*Antirrhinum majus*). The seed should be planted in a partly shaded bed in late September or early October and the little plants protected and watered in the bed all winter. Transplant in late January to permanent location. With good care they will come into bloom about April first.